Knowledge & Scientific News

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Conducted by MAJOR B. BADEN-POWELL, F.R.A.S., F.R.Met.S., and E. S. GREW, M.A.

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The Enlargement of "Knowledge."

So far as the Directors of "KNOWLEDGE" have been able to ascertain, the issue of this periodical in its enlarged form has been received with favour. The enlargement and the increase of the price to one shilling are both experiments, which have only been undertaken after the gravest consideration, and with the fullest sense of responsibility. We believe that the alteration will enable us to present to the readers of "KNOWLEDGE" a scientific publication which will, in a very much fuller way than heretofore, realise the ideals of a complete survey of all the natural sciences, and will include, in a manner not hitherto possible, articles and contributions of permanent value on topics connected with all of them.

Ornithological Puzzles.
I.—The Penguins.

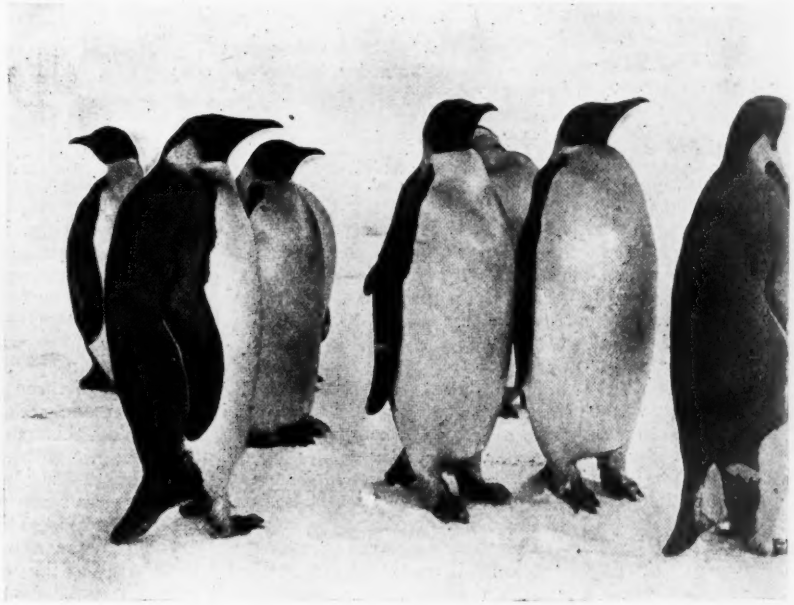
By W. P. PYCRAFT, F.Z.S., M.B.O.U.

AFTER the ostrich tribe there is probably no other group of birds which has excited so much controversy and speculation as the penguins. The expert ornithologist has found them a stumbling block for generations past, while to the unitiated they appear to form a curious and grotesque compound of bird and beast!

In this short essay little or no mention of the remarkable habits and life-history of these birds can be made, for it is proposed, rather, to dwell on their physical peculiarities, which, in interest and instructiveness, are surpassed by no other birds.

Whether seen in captivity, on the shelves of a museum, or at large, the features which first attract attention are the curiously shaped wings, and the odd, upright carriage of the body; and this because, in these particulars, they are so unbird-like. One becomes naturally curious as to the why and the wherefore of these peculiarities, and in endeavouring to discover the answer to the riddle a really fascinating insight is gained into the phenomena of adaptation to environment, and the consequent specialisation which this entails. But the story must be put together piecemeal, and much of it must be extracted from dry bones and other materials of a like kind, such as Ruskin contemptuously described as "blood and guts, and other charnel house stuff"! This has an unsavoury sound, yet those who will put away their repugnance to anything in the nature of dissecting-room evidence will find that, after all, the facts to be obtained therefrom will add immensely to their appreciation of these wonderful birds.

First of all let us take the skeleton of the wing and see whether these dry bones can be made to live. Superficially this has become transformed into a paddle, differing only from that of the old ichthyosaurs, and of modern whales and porpoises in that it is covered in degenerate feathers, in their arrangement resembling scales, though structurally differing in no essentials from typical feathers. But if the skin be removed it will be found that the muscles and the skeleton to which they are attached are in no wise different in plan from those of birds possessing fine powers of flight. Before describing the skeleton, however, it will be well to return for a moment to the wing as seen from the outside; and this just to remark that as in the paddles of the extinct reptile and the whale, there is no visible thumb, and that flexion at the wrist joint is impossible. And now as to the bones of the wing. These, in the adult, have



A group of Emperor Penguins.

(From the Album published by the Royal Society of Photographs of the Antarctic ["Discovery"] Expedition.)

become enormously flattened, but in all essential characters it differs in no wise from the typical avian wing. In two or three details, however, it is conspicuously different therefrom. Thus, the pollex has become reduced to a mere vestige fused with the base of the second metacarpal; the ulnar carpal is of relatively huge dimensions; and the phalanx of Digit III. is of great length.

A comparison between the figures of this and the wing of the embryo will show that there can be but little room for doubt as to whether the wing of the penguin was not, at an earlier stage, used for aerial locomotion, since this embryonic wing is practically indistinguishable from that of, say, the wing of an embryo pigeon or fowl; from which it differs, indeed, chiefly in the great breadth of the distal end of the humerus, and the great length of the proximal phalanx of Digit III., which, it is to be noted, supports a vestige of phalanx 2.

ment the nodules become merged with the larger crescent, and finally the whole fuses with the metacarpals. In archæopteryx the semilunar bar and its adherent 1st and 3rd carpals, remained distinct from the metacarpals throughout life; in modern birds complete fusion of the whole mass takes place very early in life.

The penguin then climbs its own ancestral tree, in this particular, as in others. That is to say, it follows the evolutionary tracks over which its ancestors passed before the flying wing became transformed into the swimming paddle. But the evidence of this evolutionary phase is incomplete—as embryological evidence always is. We can learn nothing of the way in which the wing quills which served the purposes of flight gradually vanished, or of the stages wherein the "flying" wing changed its shape to that of paddle, and thereby lost its power of flexion at the wrist joint.

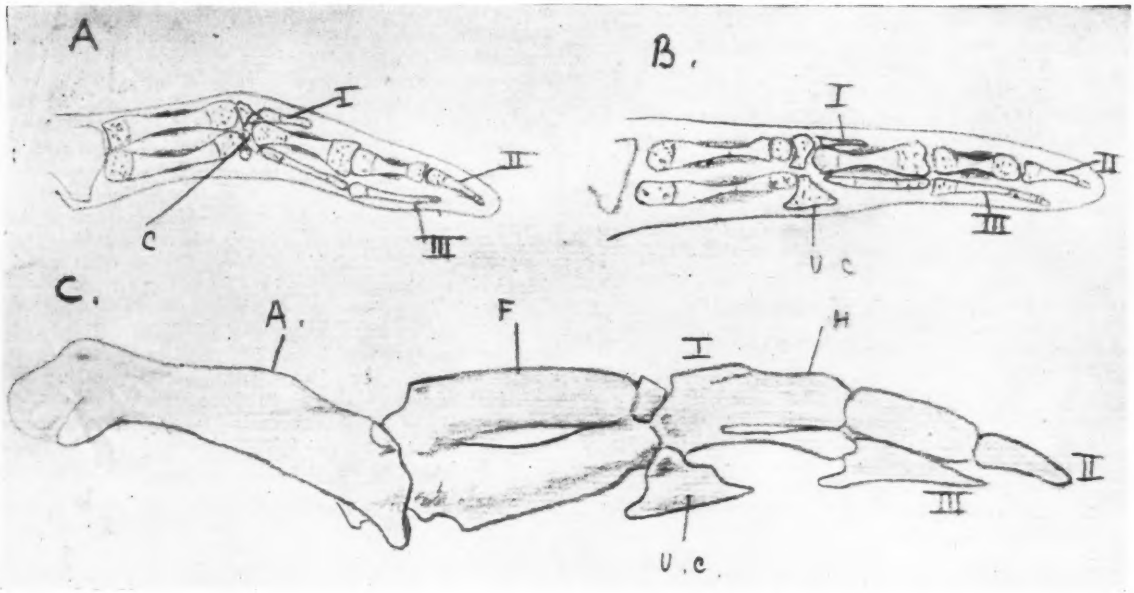


Fig. A.—Wing of an Embryo Penguin, showing the separate thumb (I), and wrist-bones (c), and the long third finger (III). The dotted parts represent cartilaginous growth points; the dark shading along the bones of the fore-arm and hand growing bone tissue. Fig. B.—A later stage of growth. Note the increase in the size of the ulnar carpal bone U.C. Fig. C.—Wing of an adult Penguin, to show the transformation into the paddle. The wing at A. is hardly distinguishable from the embryonic wing of a bird which retains the full powers of flight.

This is a very primitive character, but the wing of the embryo ostrich sometimes takes us back a step further, since this terminal phalanx is capped by a claw. The ulnar carpal, it will be noticed, shows no sign of the excessive development peculiar to the adult wing, and the pollex, or thumb, is free.

This wing is yet in the primary cartilaginous stage through which all wings pass prior to the process of ossification. In the wings of ordinary flying birds this stage is interesting because here is temporarily revealed to us an earlier and more primitive condition of the wrist bones such as obtained throughout life in that most ancient of birds, archæopteryx. That is to say, at this embryonic stage the distal or outermost row of wrist bones are clearly definable from the ends of the metacarpal or finger bones. The thumb and third finger have each a separate carpal, represented by a little nodule of cartilage, while the carpal of Digit II. forms a crescentric bar. A little later in develop-

After the wing, in point of interest, comes the leg. And this because the segment of the leg from the ankle-joint to the toes is extremely short and broad, and even in the adult shows plainly the three metacarpal bones of which it is composed. In typical birds, *e.g.*, the common fowl, this segment is round and scale-covered, and armed with a spur. In the very young bird it, too, is composed of three separate rods, but these soon fuse and form one solid cylinder. One gathers still more concerning this portion of the leg in the penguin by comparing it with that in the divers (*Colymbus*), where it is compressed almost to the thinness of a knife-edge, while the toes are so hinged that they fold up one behind the other. This is a modification of another kind, and has come about so as to offer the least possible resistance to the water in swimming when the leg is brought forward at the end of the stroke. The diver, it will be remarked, propels its body when under water by means of its feet, the wings being held close to the

body. In the penguins the wings are the propelling force, and the legs are carried stretched out behind. But the flatness of the metatarsal region of the penguin's foot is, possibly, a secondary character, and not a primitive one.

The profound structural changes which have effected such a transformation in the general appearance of the penguins have come about, it is taken as a matter of course by most of us, as the birds became more and more completely adapted to the needs of its peculiar mode of life—the capture of a swiftly-moving prey, fish, under water. Yet there is something more behind all this than we can yet fathom, for the grebes and divers among living birds are no less expert fishermen, and they have preserved the wings as organs of flight. But in these birds the legs have almost lost their power of carrying the body overland. The diver, at any rate, can scarcely walk. We must suppose, therefore, that the penguins are the descendants of birds which used their wings rather than legs in the pursuit of their prey under water; and as the struggle intensified between the competing individuals the most expert at this form of natation would get the most food and so, in time, would oust their less successful rivals. The winners, however, in this particular race gained advantage over their neighbours in proportion as their wings improved as swimming organs, and inversely, and of necessity, became less suited to perform the work of flight. Before the full significance of these changes can be realised, however, a careful study of the legs and wings and of the diving birds just referred to must be made, and this we propose to make in another chapter.

Let us turn now to quite another aspect of the penguin history—the way in which it moults its feathers. In all other birds the feathers, though shed annually, are more or less gradually displaced. But in the penguins this is not so. The new feathers all start into being at the same time, and thrust out the old feathers upon their tips so that these come away in great flakes! Further, whereas in all birds save penguins, the new feathers as they thrust their way through the skin, end in pencil-like points formed by investing sheaths; in the penguins these sheaths are open at the tips and attached by their rims to the roots of the old feathers, and hence these are held to their successors until these have attained a sufficient length to ensure protection against cold. This curious device for retaining the warmth afforded by the old feathers until the new generation can fill their places is apparently due to the fact that the penguins are essentially natives of the antarctic regions, though some species now inhabit tropical seas.

Though there can be no doubt as to the interpretation to be put upon the peculiarities of the penguin's external form, there are certain other structural characters which are not so easily understandable.

Thus the penguins, like the gannet tribe, have no external nostrils. If the latter birds were now represented only by the gannets and cormorants, and these and the penguins were the only known divers, then the reason for this would seem obvious. We should at once regard this peculiarity as a modification to prevent the ingress of water to the lungs when diving. But the grebes and quillemots, and many ducks are equally expert divers, and these have open nostrils! Then, again, take the tongue. This, in all the penguins, is studded with rows of long, conical papillæ. What purpose do they serve? They are present alike in those which feed entirely on fish and those which subsist on a diet of minute crustacea. True, this last may have been but recently adopted, but in this case the papillæ might be expected to show some signs of degeneration —assuming their origin to be associated with a fish diet.

An Emperor Penguin and its young.

(From the Album published by the Royal Society of Photographs of the Antarctic ["Discovery"] Expedition.)

The only other birds in which such papillæ occur are certain petrels, but herein they are minute. Perhaps the facts run the other way about, and, properly interpreted, we should find the papillæ were evolved to facilitate the capture of small crustacea, and that the fish diet is the recent innovation. But the problem is at present apparently insoluble.

This likeness to the petrels is matched by another, since only in these two groups we find the windpipe more or less completely divided by a median septum. What purpose can this serve? Perhaps it is but the survival of a primitive character, for the windpipe of all embryo birds is so divided. Another ancient feature, which the penguins and petrels alike have retained, is the compound character of the beak-sheath, and this they share in common with the gannet and ostrich tribe.

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This brings us to the question of the penguin's ancestry, which is by no means easy to unravel. But the evidence yielded by a study of their anatomy so far seems to show that they have descended from the same common stock as that which gave rise to the gannet tribe on the one hand and the petrels on the other, while they may also claim relationship more remotely with the divers, the anseres, the stork tribe, and the birds of prey. Be this as it may, the penguins are an extremely ancient family, for penguins whose skeletons are practically indistinguishable from those of the penguins of to-day occurred in eocene times. There is thus no link as yet obtainable which will enable us to say exactly what are their precise relationships.

And now, in conclusion, a word as to our illustrations of living penguins. These represent the Giant Emperor Penguin of the antarctic, a bird which will speedily become extinct, owing to the apathy of the authorities, who look calmly on while a company is being formed to exploit these birds for the purpose of converting their bodies into oil!

The first picture shows the bird brooding its young, which, like the egg, is placed on the back of the feet and covered by the feathers of the belly, in which peculiarity it agrees with its cousin the King Penguin. But this theme demands a chapter to itself, which we may be permitted to give on a future occasion, for the nursery habits of these birds present some very extraordinary features.

In the second photograph, which, like the first, was taken by Dr. Wilson during the National Antarctic Expedition, shows a group of Emperors at rest. This well illustrates the upright carriage and the use of the spiny tail as the third leg of a tripod in supporting the body.

MR. H. E. GABRIEL, of Brondesbury, London, N.W., writing in answer to Mr. H. L. Meadows, who, in his letter on the physical constitution of the moon, that appeared in the January number, suggested that the formation of the mountains and craters of the moon had been brought about by the action of external causes, says: "I do not think his theory tenable, although admitting the difficulties of wholly accounting for the configuration of the lunar surface by internal or volcanic agency. He supposes that pieces have been transferred from the earth and have produced the variety of objects seen on the moon's surface. But I would point out that, at the period at which these objects must have been formed, the earth was not in a condition for 'solid particles' to have existed as such on its surface. The generally accepted theory, viz.: that of volcanic forces alone, is certainly not quite satisfactory and does not fully account for the facts. It would seem that the origin of some of these lunar features must be referred to the action of internal forces, and of others to that of materials from without, in the form of meteoric bodies."

AMONG the serial publications now being issued, **"The Nature Book"** (Cassell and Co., 24 Parts, each 7d. net), Part 18 of which has just reached us, still maintains its high standard of articles and pictures of popular scientific interest. **"The Wild Beasts of the World"** (T. C. and E. C. Jack, 17 Parts, 1s. each), judging from the first 7 parts that have been published so far, should form, when complete, a really attractive natural history for the layman. It is intended that during the series altogether 100 full-page coloured plates shall be presented with the work, and these are to be produced "so as to be scientifically representative and artistically attractive," to use the words from the prospectus. The latter desire has certainly been accomplished, rather to the detriment of the former. In addition to the hundred species, of which plates are given, many others will be dealt with in the literary portion of the work. To those of our readers resident in the provinces or abroad who may like to have a pictorial history of London, we can recommend **"London Town, Past and Present."**

An Irish Astronomical Tract.

By J. E. GORE, M.R.I.A.

IN the library of the Royal Irish Academy there is an astronomical manuscript written about the year 1400 A.D. It is written in Irish, but is, at least for the most part, a translation from the Latin. The original Latin version was a translation from the Arabic of Messahalah, or Masch Allah, an Arabic astronomer who lived about the close of the 7th century. A portion of another copy of this MS. is in the Academy library, and a third copy, nearly complete, is in Marsh's Library, Dublin. The three copies apparently differ but little as to the dates at which they were written. The tract contains numerous diagrams, and those in the Academy copy are superior to those in the copy in Marsh's Library.

Messahalah was well known in Europe in the Middle Ages as an astronomical writer, and some of his works are still extant in Latin translations. These works seem to have been highly thought of in those times. He lived in the reigns of the Khalifs Al-Mansur and Haroun al Raschid, that is, within the period A.D. 754 to 833. He was, therefore, a contemporary of the famous Arabian astronomer Alfragani. He seems to have been a Jew.

The astronomical tract at present under consideration was translated into Latin in the 13th century by Gerard of Sabbionetta, near Cremona. This translation was edited by J. Stabius with the title *De Scientia Motûs Orbis*, and was printed at Nuremburg in the year 1504 A.D. It was afterwards edited by Joachim Heller, with the title *De Elementis et Orbibus Coelestibus*, and printed at Nuremburg in 1549. There is also a Latin MS. in the Bodleian Library, and this agrees well with the editions of Stabius and Heller.

Messahalah's work is chiefly based on Aristotle's works *De Coelo* and *Meteorologica*, and on Ptolemy's *Almagest*.

A considerable portion of the matter contained in the Irish manuscript does not appear in the Latin versions of Messahalah's work, and this seems to have been derived from Arabian sources of, perhaps, later date than the time of Messahalah. Indeed, some of it seems to be of much later date. For example, reference is made to spectacles, which seem to have been first used about 1340 A.D. Other facts seem to show the same thing. This extra matter does not seem, however, to have been added by the Irish translator, for he gives the Latin headlines of the chapters in question, showing that they existed in the original Latin from which he translated. Possibly the intention of the Irish writer was to compile a text-book for Irish students, and probably it was used for this purpose in Ireland. The MS. in the Royal Irish Academy Library was bought in 1673 by Thomas Astle, F.R.S., Keeper of the Records in the Tower of London. Mr. Astle died in 1804, and the MS. then came into the possession of the Marquis of Buckingham at Stour. It was bought by the Earl of Ashburnham about the year 1849. In the year 1883 the Ashburnham collection of MSS. was deposited by the Treasury in the Library of the Royal Irish Academy, where it still remains. In the year 1893 the Irish MS. was translated into English by Mr. J. J. O'Farrelly at the request of the late Rev. Maxwell H. Close, who was then Treasurer of the Royal Irish Academy; and some account of the contents of this valuable tract may prove of interest to the general reader.

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The work consists of 39 chapters, of which 12 are not due to Messahalah, or, at least, are not contained in the Latin versions of the tract. In the first chapter the writer begins by stating that the firmament is globular, and was "created and appointed under the guidance of the Creator himself." The fixed stars, he says, are in the 8th firmament, and "fixed like nails in a board," with no motion of their own, but moving with the sphere itself. On this theory the origin of the term "fixed stars" is obvious. The annual motion of the star sphere and return of the seasons prove, he says, that the Creator is still directing and ruling the world.

In the second chapter it is stated that the earth is a globular mass in the middle of the system without anything to support it. Around the earth is water, and around that is the air. Round the air is fire, and surrounding all is the "firmament." He gives a diagram of concentric circles, showing earth, water, fire, and firmament, like the coats of an onion.

The third chapter deals with motions. He says there are three motions, viz.: (1) from the centre; (2) towards the centre; and (3) motion round the centre, and says that all motions are derived from these three. The two elements which move *towards* the centre are earth and water; those which move *from* the centre are air and fire; earth being the heaviest, and air the lightest. The third motion seems to be represented by the daily rotation of the star sphere.

The fourth, fifth, and sixth chapters deal with the "primary qualities" of the four elements. Of these the "active principles" are heat and cold, as in fire and ice. The "passive principles," such as "dryness" and "wetness," are represented by earth and water. All bodies, he says, are compounded of these four "elements." This was the idea of the ancients.

In the seventh chapter, which is not in the Latin version of Stabius, and was not probably due to Messahalah, the Irish writer shows that the shape of the earth is globular, and argues very correctly that the reason we do not see the stars in the southern skies is that they are hidden by the rotundity of the earth. There were evidently "earth flatteners" in those days, for he says: "And whoever should say that the earth is a plane surface without curvature, and that the sun rises at one side of it and sets at the other, we may say that it is impossible to find a reason or any argument to prove that. For if that supposition were true, the sun would appear to be small when rising, and in proportion as it mounts upwards and comes near to us it would appear to be larger and larger. But it is evident to everybody in the world who has seen it that such is not true, since we see that it is of equal size in the east and west, and in the highest point of the world. And hence it is proved that the earth and the course of the sun round the earth are both circular." This, however, does not prove conclusively that the earth is globular; the argument from the stars is much stronger. He refers to the *apparent* enlargement of the sun near the horizon, which seems to have been noticed at a very early date, and explains it by "vapours" and "haziness" near the horizon. This opinion was also held by Poseidonius in ancient times. But its truth is more than doubtful, and the phenomenon is now thought to be due to a physiological cause. In this chapter spectacles are referred to as being used by "old people." He gives further arguments to show that the earth is not flat, and says "if you were in the city of Jerusalem the sun would set to you at Rome; and were you there, she would set to you in the west of France; and you being there she would set to you in the west of Spain.* And after that some place of the western sea would shut her out from your view. And if the sea would permit you to follow the sun she would change her setting each day that you would follow her until finally she would set where you saw her rise in the city of Jerusalem."

In chapter 8, which is not in Stabius' Latin edition of Messahalah's work, the Irish writer speaks of the wearing down of the mountains by the action of rivers. He says "the rivers carry with them to the sea the earth which they find softest, and this being there for a vast length of time it hardens and consolidates, and is formed into stone." This and subsequent remarks on fossil shells found on the tops of mountains agree remarkably well with the principles of modern geology.

Chapters 9 and 10, which are also missing in the Latin of Stabius, treat of the heat of summer, the cold of winter, earthquakes, volcanoes, mineral springs, the saltness of the sea, etc., and much of this seems to be derived from Aristotle's *Meteorologica*.

In chapters 11 and 12, which are also absent from the Latin of Stabius, the tides and the annual rising of the Nile are discussed. The remarks on the tides agree well with the views of Pliny, Poseidonius, and Strabo. With reference to the rising of the Nile the Irish writer says: "Some of the unlearned assert that the flood of the River Nile comes from the great rains which pour down in distant parts of the country; and that, according as the river fills, it overflows the land of Egypt. And what the rain does in other countries, it is that which the water of the Nile does to the Egyptians. But we say that they have no argument or reason to prove this, but only a supposition." It is, however, now known that the above *is* the true explanation of the phenomenon.

In chapter 13, which is found in the Latin edition of Stabius, the writer explains, or tries to explain, that "the firmament cannot be compounded of the four elements."

In chapters 14 and 15, which are not in the edition of Stabins, the Irish writer discusses the uniform and steady motion (or, rather, apparent motion) of the star sphere round the earth; and the habitable and uninhabitable regions of the earth's surface. He places the limits of habitability at the 65th degree of latitude north and south of the equator. He refers to the signs of the Zodiac, and says that, according to the "ignorant," "Aries, Leo, and Sagittarius are warm and dry, according to the nature of fire; Taurus and Virgo, according to the nature of air; Cancer, Scorpio, and Piscis [*sic*] cold and wet, after the nature of water." These ideas have probably an astrological signification. He refers to the unchangeability of the firmament, and this seems to be derived from Aristotle's work, *De Coelo*.

Chapter 16, which agrees closely with the Latin edition of Stabius, deals with the imaginary lines on the star sphere. But the description of these circles is very imperfect and sometimes erroneous. The important circle of the ecliptic is omitted!

Chapter 17, which is not in the edition of Stabius, deals with "the difference in the rising and setting of the sun in various countries." The Irish writer states that "the sun rises sooner to Babylon than to Egypt; and to Egypt than to Africa.† And in like manner she sets sooner to Babylon than to Egypt; and sooner to Egypt than to Africa."‡ This he explains by a dia-

* The geography here seems to be rather inaccurate. It seems curious that the sun is referred to as "she."

†‡ By "Africa" is probably meant Carthage.

gram, and says correctly that "it is the rotundity of the earth which causes the variety of the sun's rising and setting in the world."

In chapter 18 the Irish writer deals with the sun's magnitude. He says that Ptolemy proved the great size of the sun, and argues that if the earth and sun were of the same size the shadow of the earth would extend to the sphere of the fixed stars and obscure their light. But Ptolemy believed—as Mr. Close pointed out—that the stars shine by their own inherent light, and, further, it is evident that even if the earth had the same diameter as the sun the earth's shadow would be quite lost when projected on the star sphere. He then supposes that the earth is larger than the sun, and argues that in this case the earth's shadow would widen out and "would obscure the greater part" of the stars. He also says that there would be an eclipse of the moon every month, which "would last throughout the night until morning." But these statements are quite incorrect, as Mr. Close has pointed out. He says, and this is correct, that the shape of the earth's shadow is a cone, and that it "never passes beyond the orbit of Mercury, but ends not much beyond the upper side of the moon's sphere."

Chapter 19 deals with the origin of the moon's light, which the writer says "it receives from the sun." He thinks that the stars also shine by reflected sunlight. This idea was held by many of the ancient astronomers. Even Copernicus seems to have thought so! The phases of the moon are explained with sufficient accuracy, but some of the diagrams given are incorrectly drawn.

In chapter 20 the writer deals with eclipses of the moon, which he explains correctly, but seems to think that a lunar eclipse may be partial at one place on the earth's surface and total at another (like a solar eclipse), which is quite incorrect. If an eclipse of the moon is total at any place it is so to every point on the earth's surface from which the moon is visible at the time.

In chapter 21 the writer again returns to the light of the stars, and says "the light of all the stars comes from the sun," and "they are as round as a ball, like the sun and moon." He speaks of the phases of Mercury and Venus, and says "when they are twelve degrees proceeding westward of the sun they are horned like the new moon." This fact could not have been derived from Messahalah's work, for Messahalah could not have known anything of the phases of Mercury and Venus.

In chapter 22, eclipses of the sun are considered, and the writer correctly maintains that they are caused by the interposition of "the body of the moon," which cuts off the light of the sun. He shows that the moon sometimes passes above or below the sun, and "thus avoids producing an eclipse." He states—correctly in this case—that eclipses of the sun are visible in some places and not at others. He says that in a total eclipse "the fixed stars become visible at mid-day, so great is the darkness." He also clearly refers to the possibility of "annular eclipses" of the sun "when the moon is exactly beneath the sun in one straight line with her, and it is far from being as broad as she." He also refers to possible transits of Mercury and Venus across the sun's disc.

Chapters 23 and 24 deal with the variation of moonlight at different times of the lunar month. The writer says that the moon first becomes visible in the evening sky when it is about 12° distant from the sun.* He says "if you wish to see the fixed stars in the day go in the morning or evening into a deep, dark hole, and look above your head, and you will see them clearly in the summit of the firmament above your head." But this is not the case, and has been often disproved.

Chapters 25 to 29 treat of the imaginary lunar and solar "spheres" and the "sphere of the stars." These are the "deferents," "epicycles," and "excentrics" of the ancient astronomers, and have long since been swept away by the "light pressure" of modern science. In chapter 28 the writer ascribes the precession of the equinoxes (as it is now termed) to a motion of the star sphere from west to east. This agrees with Ptolemy's view. Copernicus, however, thought that the precession was caused by the *westward* movement of the equinoctial points, and this is, of course, the true explanation of the phenomenon.

In chapter 30 the writer deals with the seasons, but here his ideas seem rather confused.

Chapter 31 deals with the supposed "spheres" of the planet Saturn and their relation to other "spheres," but his remarks are, in part, quite erroneous.

Chapter 32 discusses the "retrograde motion" of Saturn and the other exterior planets. As is well known, these retrograde motions were fairly well represented by the old "deferents" and "epicycles."

Chapter 33 deals with the "sphere of the fixed stars," which, the writer says, has a motion "ever and always from west to east of the world." This seems to refer to the apparent annual motion of the sun among the stars.

Chapter 34, which is not in the Latin edition of Stabius, deals with the size of the earth. The writer concludes that the length of a degree is about $66\frac{3}{4}$ miles,* and that the circumference of the earth is about 24,000 miles, which is a good approximation to the true value. The diameter, he says, is, therefore, about 8,000 miles. This makes the value of $\pi = 3$, but, as Mr. Close points out, Archimedes long before made its value between $3\frac{10}{70}$ and $3\frac{10}{71}$

Chapter 35, which is not in the edition of Stabius, treats of the "seven habitable regions of the earth." Here we are told that, according to the ancients, all the habitable parts of the earth lie between the equator and the North Pole, and that from the equator to the antarctic pole "no animal whatever can exist therein through the excess of heat"! The habitable portion north of the equator was divided into seven zones or "climates." According to Mr. Close, the 6th climate extended from latitude $48\frac{1}{2}°$ to latitude $54\frac{1}{2}°$ north, and the 7th from $54\frac{1}{2}°$ to $58\frac{1}{4}°$ north. Hence Ireland and nearly the whole of the British Isles lie within these two divisions. With reference to the 6th "climate," the Irish writer says "the people of this region are weak of body, and of bright colour, having sleek hair, brutal and intractable"; and of the 7th "climate" he says "the inhabitants of this region are unintelligent, hard to be instructed, weak of understanding, and of deficient memory, weak in body, and have fair, fine, yellow hair." If these descriptions are at all correct the inhabitants of the British Islands must have improved greatly since ancient times.

Chapter 36, which is not found in the Latin edition of Stabius, treats "of the places in which the entire year is one day and one night." This, of course, refers to the Arctic and Antarctic regions, and the phenomena are fairly well described.

Chapter 37, which is in the Latin of Stabius, treats

* This is, on the average, nearly correct.

* $66\frac{2}{3}$ miles in the copy in Marsh's Library.

"of the winds and their natures." Some of the ideas contained in this chapter seem correct enough, but others are rather hazy and confused. For example, the writer states that in great battles the movements of the contending armies "raises a wind," which, as Euclid says, "is absurd."

Chapter 38 deals with "clouds, thunder, rain, and lightning." The formation of clouds is fairly well explained, but the explanation of thunder and lightning is confused and inaccurate. The writer explains why it is that, although the thunder and lightning are produced simultaneously in one place, the lightning is seen before the thunder is heard, viz., that sound travels with a less velocity than light. He seems to think, however, that the velocity of light is immeasurably great, for he says that "the eye sees in the same way the object which is near and that which is distant." This is, of course, incorrect, but for lightning it is practically true, as thunder clouds are always near the earth.

Chapter 39 treats "of the living things which grow, but have no sense." This, of course, refers to plants, and the writer gives a fairly accurate account of vegetation. According to Mr. Close this chapter "differs a good deal from the corresponding chapter in Stabius," and seems to be based on Aristotle's work, *De Plantis*.

A Swiss Popular Observatory.

THE *Urania* of Zurich, which has been recently inaugurated, is a completely equipped popular observatory accessible to the general public. It comprises a large telescope with a twelve-inch objective lens. In order to eliminate any disturbances due to oscillations of the ground, the telescope has been mounted on a pillar which, beginning from 12 m. below the level of the street, towers freely to a total height of 52 m. without anywhere touching the building itself.

Fig. 1.—View of Urania.

Electric lifts are provided to ensure access to the elevated cupola enclosing this instrument. The cupola is rotated round its axis by an electric motor, and the section through which the sky is observed can be adjusted in any direction. The movement of the telescope, which has been constructed by Carl Zeiss, of Jena, is also effected by electricity.

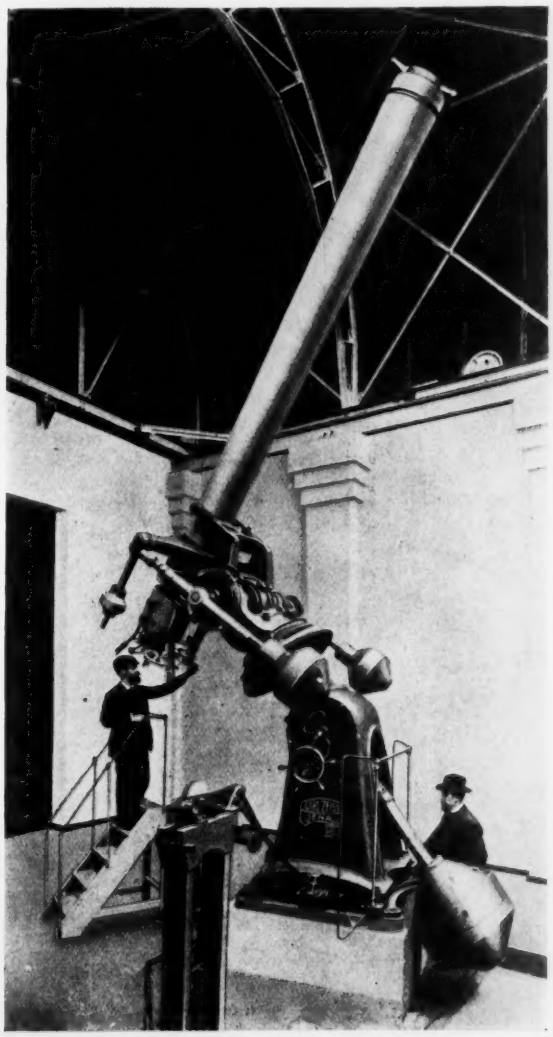

Fig. 2.—Large Telescope of Urania.

In connection with solar observations, special devices are used for reducing the intensity of heat and light radiations so as to prevent any harm to the eye. Fig. 3 represents a projection device used to produce the image of the sun on a screen. The white disc seen in the figure is the magnified image of the sun with a group of sunspots. Fig. 4 represents the telescope fitted with a special type of camera so as to allow photographic exposures to be continued for several hours.

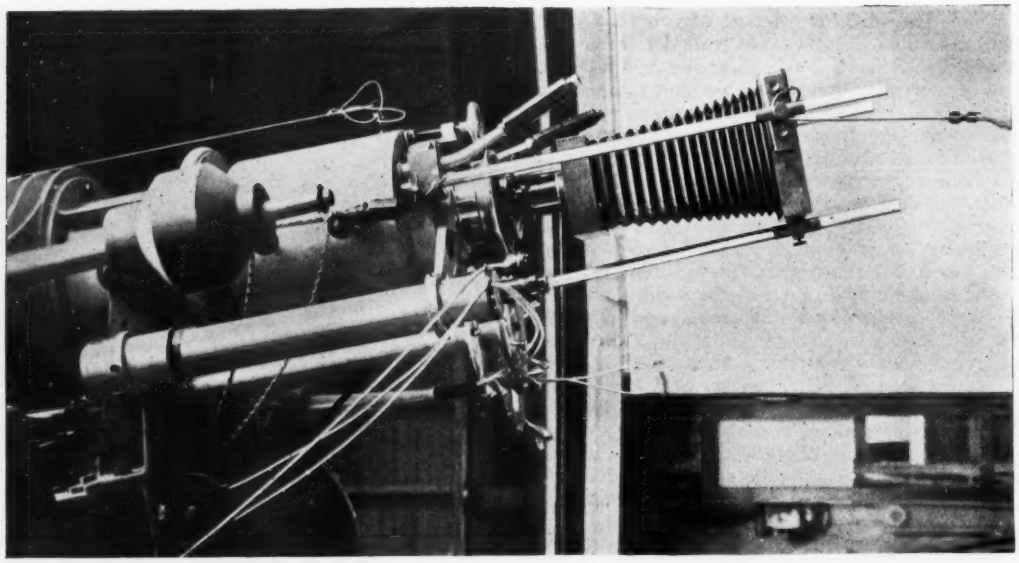

Fig. 4.—Telescope Head fitted with special camera for Stellar Records.

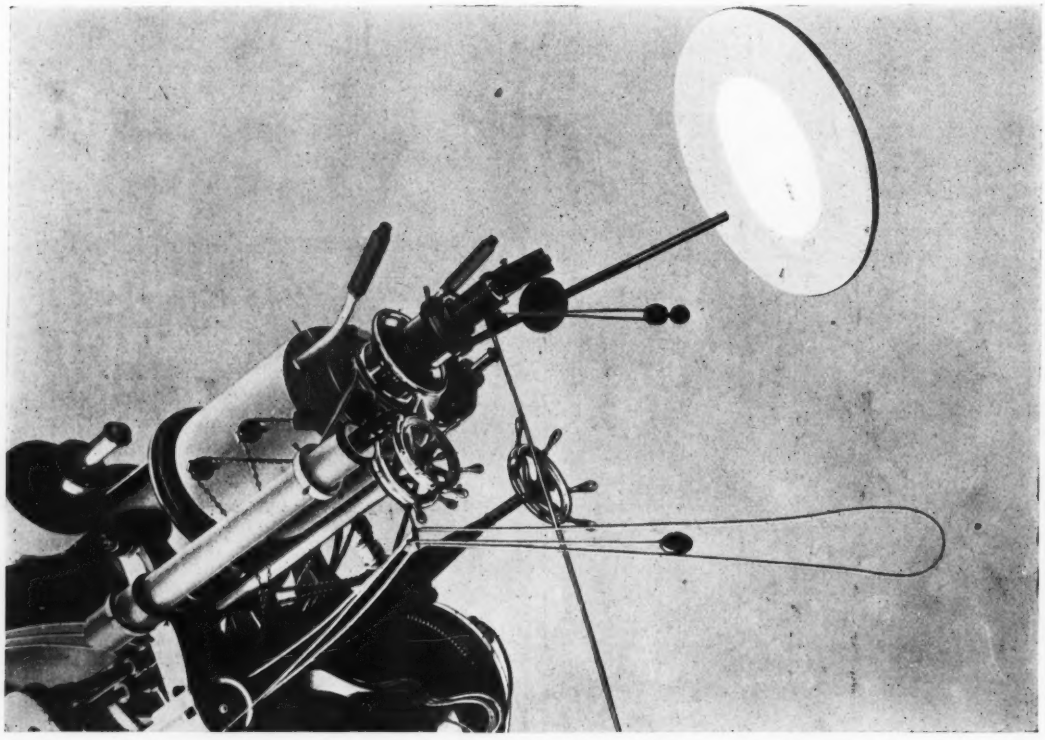

Fig. 3.—Telescope Head with Projector for Sun Observations. Group of Sunspots can be seen upon white disc.

Twin-Earthquakes.

By CHARLES DAVISON, Sc.D., F.G.S.

IF earthquakes be classified according to the nature of the shock, three distinct kinds may be recognised. In the simplest of all, such as those which constitute the majority felt in this country, the shock begins with weak vibrations, which increase rapidly in strength until a maximum is reached, and then die away into a tremor, the whole lasting about six or eight seconds. On the other hand, in earthquakes of the first magnitude, the movement is extremely complex in character. Vibrations of different amplitude and period are felt

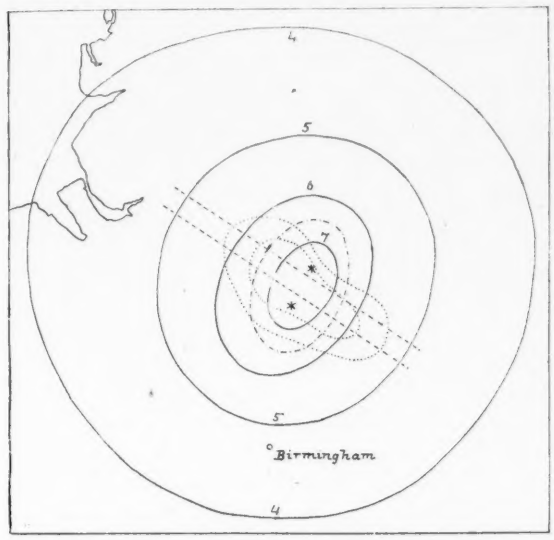

Fig. 1.

together, there may be several or many fluctuations of intensity, and the total duration may amount to three or four minutes. In the intermediate class the earthquake consists uniformly of two series of vibrations, separated by an interval of rest and quiet lasting it may be for two or three seconds. In each series the vibrations increase in strength to a maximum and then die away, the total duration of the shock, including the interval, varying from about eight to twelve seconds. To this class the name of *twin-earthquakes* has been given, for they are due, as will be seen, to two separate impulses resulting from a single generative effort.

Among British earthquakes the strongest shocks are nearly always those of twin-earthquakes. Such are the Pembroke earthquakes of 1892 and 1893, which disturbed areas of 44,800 and 63,600 square miles, the Colchester earthquake of 1884 with a disturbed area of 50,000 square miles, the Hereford earthquake of 1896 with one of 98,000 square miles, and the Swansea earthquake of 1906 with one of 66,700 square miles. This list includes all the great earthquakes of the last quarter of a century, with the exception of the Inverness earthquake of 1901 and the Carnarvon earthquake of 1903, which were felt over areas of 30,000 and 25,000 square miles. As typical examples of twin earthquakes, I propose to describe here the two Derby earthquakes of March 24, 1903, and July 3, 1904.

The first of these occurred at 1.30 p.m. In the accompanying sketch-map (Fig. 1) the continuous curves represent isoseismal lines of intensities 7 to 4 of the Rossi-Forel scale. To illustrate the nature of the shock, accounts may be selected from five places, of which Ashbourne and Darley Dale are close to the longer axes of the inner isoseismals and on either side of their common centre, Duffield on the continuation of the shorter axis of the same curves, while Quarndon and Derby are respectively 1½ and 3 miles from that axis. At Ashbourne two distinct shocks were felt, the first twice as long as the second and also rather stronger, the interval between them being about one or two seconds; at Darley Dale there were also two parts, of which the second was the stronger. At Derby the two parts were separated by an interval of about half a second, and were very nearly equal in strength, though the first was slightly the stronger. At Quarndon the two parts of the shock were represented by two maxima of intensity connected by weaker tremulous motion; while at Duffield only a single shock with one maximum of intensity was observed. At Birmingham, which lies not far from the longer axis of the isoseismal lines, the earthquake was registered by an Omori horizontal pendulum. A copy of the records is reproduced in Fig. 2, the letters *a* and *b* denoting the strongest vibrations of the two parts of the shock.

The area disturbed by this earthquake was not less than 12,000 square miles, and in all parts of it, with the exception of certain places like Duffield, the double shock was observed. When all such places are plotted on a map, and also those where there was only one shock, a definite law of variation is at once evident. The single shock was felt within a narrow rectilinear band, about five miles wide, running centrally across the inner isoseismals in a direction at right angles to their longer axis. The boundaries of this band, known as the *synkinetic band*, are represented by the broken lines in Fig. 1. Outside the band there was always an appreciable interval between the two parts of the shock, its average length being three seconds, but, at places (like Derby) close to the band, the interval was much shorter than elsewhere, while near the boundaries of

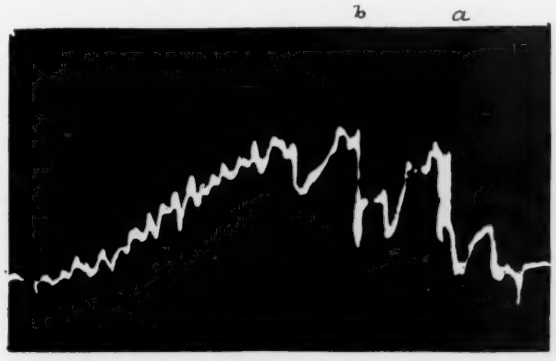

Fig. 2.

the band (as at Quarndon) two maxima of intensity were observed.

It is evident, from the wide area over which the twin-shock was felt and from the existence of the synkinetic band, that the two series of vibrations cannot have been due to the duplication of a single impulse by reflection or refraction, to the separation of the direct and transverse waves, nor to the repetition of the impulse within

the same focus. The only possible interpretation of the evidence is that there were two detached foci, and, moreover, that the impulses within them occurred at the same instant, otherwise the synkinetic band, in which the two series of waves coalesced, would have been curved and not straight. The two impulses were nearly equal in strength, though that within the southern focus was slightly the stronger.

If further proof of this explanation were needed, it would be found in the forms of the isacoustic lines, two of which are represented by the dotted lines in Fig. 1. These lines are drawn through all places at which the percentage of observers who heard the earthquake sound are the same, the inner curve corresponding to a percentage of 95, and the outer to one of 90. These curves, it will be noticed, are elongated in the direction of the synkinetic band, and their peculiar forms are due to the coalescence of the rapid vibrations from the two foci and the consequent strengthening of the resultant sound.

The exact positions of the epicentres corresponding to the two foci cannot be determined in this earthquake, but they are indicated approximately by the stars in Fig. 1, the distance between the epicentres being thus about eight or nine miles.

Forty days after the earthquake on May 3 a slight shock was felt in the central part of the disturbed area. In order to simplify the map in Fig. 1 the only isoseismal shown is that which bounds the disturbed area, represented by the broken and dotted line. The intensity of the shock was 5 near the centre, and the area disturbed by it about 585 square miles. The shock in all parts consisted of a single series of vibrations. It was, therefore, not a twin, but was caused by an impulse within a single continuous focus. And, since the isoseismal lines are concentric with those of the

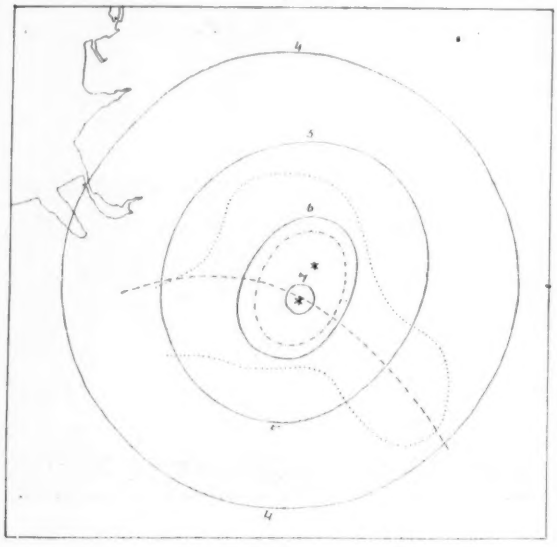

Fig. 3.

principal earthquake it follows that this focus must have been situated between the foci of the latter, though possibly overlapping them slightly.

A somewhat similar twin-earthquake occurred in the same foci a little more than a year later, on July 3, 1904. The intensity of this shock was slightly less than that of 1903, but, as it occurred at 3.21 p.m., during the restful hours of a Sunday afternoon, it was much more widely observed. In Fig. 3 the continuous curves represent isoseismal lines of intensities 7 to 4, and it will be noticed that the innermost curve is eccentric with regard to the others, thus fixing the position

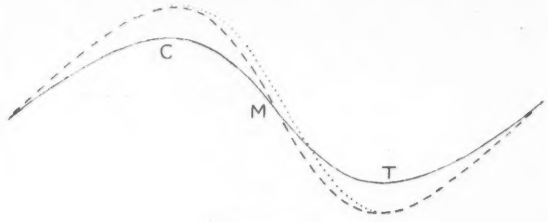

Fig. 4.

of the southern epicentre, and indicating that the two impulses were of unequal strength, the stronger one occurring within the southern focus. The inequality of the two impulses is also evident from the fact that the twin-shock was felt over an area of 8,000 square miles, while the stronger part alone was sensible over an area of 25,000 square miles. As in the previous year, the twin-shock area is traversed by a synkinetic band within which the two parts of the shock were superposed. The boundaries of the band in this case cannot be traced with accuracy, but the course of its median line is indicated by the broken line on the map. The dotted line, incomplete towards the west, represents an isacoustic line corresponding to an audibility of 80 per cent. As in the previous shock, the isacoustic line shows a marked expansion along the synkinetic band. The positions of the epicentres are indicated as before by stars, the distance between them being six or seven miles.

The curved form of the synkinetic band, its neighbourhood to the southern focus and concavity in that direction, are the chief points of difference between the two earthquakes. In 1903 the impulses were simultaneous; in 1904 the impulse within the northern focus must have preceded that within the southern focus by a very short interval, possibly not more than a fraction of a second, for the form and position of the synkinetic band show that the waves from the northern focus had travelled farther than the waves from the other focus before the two coalesced.

Again, as in 1903, the principal earthquake was succeeded by a slight shock in the central district, this time after a lapse of only eight hours, at 11.8 p.m. The boundary of its disturbed area is shown by the broken and dotted line in Fig. 3, the isoseismal 4 being omitted for simplicity. Both isoseismals, however, are concentric with those of the after-shock in 1903. The intensity of the shock was 4, and the disturbed area 425 square miles All over this area the shock consisted of one continuous series of rapid vibrations lasting about $3\frac{1}{2}$ seconds. Thus, as before, the after-shock was not a twin, and its focus lay chiefly in the interfocal region of the principal earthquake.

Next to the existence of two detached foci the most significant feature of these twin-earthquakes is the synkinetic band. The mere fact that the waves from the two foci coalesced along a band passing between the corresponding epicentres shows that the interval between the occurrence of the two impulses, when not absolutely simultaneous, was less than the time taken

by the earth-waves to cross the interfocal region. In other words, the second impulse was not a consequence of the first. It was not due, as in an after-shock of a simple earthquake, to the increased stress resulting from an earlier displacement. The impulses must have originated in two detached regions by a single generative effort.

Simple displacements, either simultaneous or successive, being thus incapable of producing a twin-earthquake, the only movement that can do so is one of rotation; and in the formation of crust-folds, and especially along their transverse intersection by faults, it is evident that such movements must be taking place continually. In Fig. 4 the continuous line is supposed to represent a stratum of a crust-fold; C the crest, T the trough, and M the middle limb, and the broken line the same stratum after a step in the growth of the fold. The result of such a movement will clearly be displacements, nearly or quite simultaneous, in two detached foci C and T, with an intermediate region of little or no displacement in that portion of the middle limb M about which the rotation has occurred.

If the explanation be a correct one the mean distance between the epicentres of twin-earthquakes should be roughly equal to that between successive crests and troughs of crust-folds. The materials for an estimate of the latter distance for this country do not exist in an accessible form, but for France the mean distance, as measured along several lines of Professor Marcel Bertrand's map of synclinal folds, lies between nine and twelve miles. The mean distance between the epicentres of British twin-earthquakes is about ten or eleven miles.

The after-shocks of the Derby earthquakes have an important bearing on two other points in connection with the origin of twin-earthquakes. The directions of the longer axes of their isoseismal lines are N. 25° E. and N. 27° E. in 1903 and 1904 respectively; with those of the innermost isoseismals of the principal earthquakes are N. 32½° E. and N. 31° E. Now, the after-shocks being simple earthquakes, the disturbed areas must be elongated in the direction of the originating fault. But the isoseismals of the twin-earthquakes are compounded of the isoseismals corresponding to each impulse, and expand farther on the side towards which the fault slopes or hades than in the opposite direction. If, however, the hade were the same in both foci, the axes of the compound isoseismals would be, roughly, parallel to the fault-line. Their divergence from the axes of the isoseismal lines of the after-shocks thus shows that *the fault hades in opposite directions within the two foci*, towards the south-east in the northern focus, and towards the north-west in the southern, changing hade in the interfocal region of the middle limb. The bearing of this conclusion on some recent geological researches, and especially on those of Professor Lapworth, needs no more than a passing reference.

Again, the facts that the after-shocks were simple and not twin-earthquakes, and originated in the interfocal regions, indicate that they were caused by *simple displacements without rotation of the middle limb*, say, from the position represented by the broken line. But, Fig. 4 to that represented by the dotted line. But, since the intensity of the after-shock is far less than that of the twin-earthquake, it follows that the translation of the middle limb is much less in amount than the previous displacements of the crust and trough, that is, that *the movements which cause a twin-earthquake and its successor result in accentuating the form of the crust-fold*.

Luminous Plants.

By DR. ALFRED GRADENWITZ.

SOME species of beetles, as is well known, are endowed with a strange luminescence, and the beautiful phenomenon known as phosphorescence of the sea is, in its turn, due to the light given out by certain of the lower organisms. Many organic substances exhibit luminous phenomena of a similar kind and butcher's meat, at a state of beginning decomposition, as well as rotten wood and withered leaves, possess a luminescence readily perceived by the eye when at rest.

Naturalists have frequently discussed the question as to what profit those organisms may derive from their remarkable power, and it seems possible that certain animals avail themselves of their luminescence in attracting their prey, frightening their foes, or lighting the environs when seeking their food.

Not only the luminescence of insects, but that of other organic substances as well, should be ascribed to a vital

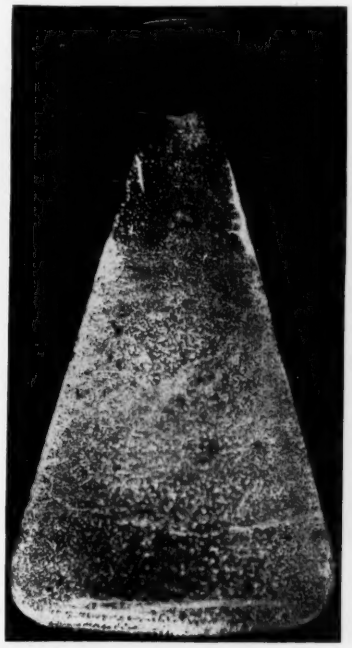

Fig. 1.—"Living" lamp photographed in its own light.

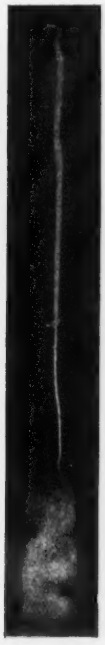

Fig. 2.—Luminous Bacteria Cultures.

process, being due to bacteria, that is, to vegetable organisms settling on the surface of the substance in order thence to spread to other bodies.

Professor H. Molisch, of the University of Prague, has closely investigated those phenomena of vegetable luminescence during his voyages of discovery in the tropics and after his return to Europe. According to his researches, the luminescence of butcher's meat, so far from being an exceptional phenomenon, is an absolutely general fact, occurring even in the case of relatively fresh meat, which is quite susceptible of being used as food.

The *bacterium phosphoreum*, which gives rise to this luminescence, accordingly is of very widespread occurrence, being found in all ice cellars, in which the meat, soon after its arrival, is again and again contaminated by those luminous fungi. Eggs kept in salt

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water and boiled potatoes will take the same characteristic luminescence either spontaneously or on coming into contact with meat, and the same applies to dead sea fish and other sea animals, in the case of which the phenomenon takes place at the very beginning of disintegration, before any bad smell can be noted. Professor Molisch, therefore, unhesitatingly asserts that at least during the hot season a large portion of all the fish in the market is sold in a luminous condition without the knowledge of the public, but without any detriment to health. In contradistinction to sea fish, freshwater fish do not show any spontaneous luminescence, but become luminescent on coming into contact with sea animals, or with butcher's meat contaminated by the bacteria. As the presence of free oxygen is required to enable these to give rise to the phenomenon, this would seem to be an oxidation process, in which only the bacteria situated near the surface partake so as to come into contact with atmospheric oxygen. It is true that the amounts of oxygen taking part in the oxidation are extremely small, being detected by no known chemical reagent. Some experimenters have,

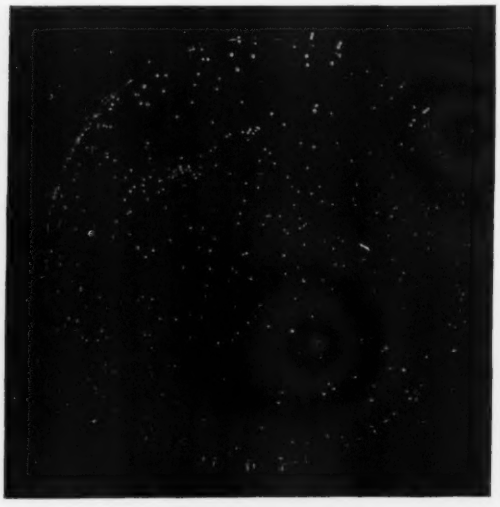

Fig. 3.—Luminous Bacteria photographed in their own light.

accordingly, suggested a very intimate connection between this luminosity and the process of respiration, considering the former as the immediate outcome of the latter. Outside of the oxygen a certain amount of water is indispensable to give rise to the phenomenon, as shown by the fact that bacteria placed on a glass plate, owing to the evaporation of their water, will cease to shine after 5 to 10 minutes, in order to recover their luminosity after some water has been added.

Professor Molisch's researches thus show that the luminosity of living organisms is a chemical process giving rise to the formation of a hypothetical substance in the interior of cells, which, in the presence of free oxygen and water, becomes luminous. This the experimenter calls "photogen."

The luminosity of animals shows a characteristic difference from that of plants (bacteria), in so far as the former is observed only intermittentiy, while cultures of bacteria may remain luminescent for months and even years, provided there be a sufficient supply of food.

Professor Molisch then succeeded in preparing with a glass flask filled with sterilised gelatine vaccinated with a culture of luminous bacteria, a "cold lamp," which, though being of less intensity than the flame of even the smallest candle, perfectly sufficed for scientific researches, photographic purposes, and even for certain practical uses. As luminous beetles have at any time been used by the natives of tropical countries as ornaments, fishing and hunting utensils, and as optical telegraphs in warfare, the possibility of eventually increasing the intensity of those living illuminants sufficiently to allow of a more extensive utilisation should by no means be discarded.

Fig. 4.—A Bust of Schiller, the poet, as photographed with "living" lamp.

The most striking difference between this "living" light and the one given out by other illuminants is the perfect absence of heat rays. Nature thus realises the ideal of modern engineers, viz., the production of light without heat. While being free from any material heat radiation, this light, however, is by no means of simple composition, and, *e.g.*, comprises chemical rays. Molisch, accordingly, succeeds in photographing luminous cultures in their own light and various other objects in the light of the bacteria. "Living" light does not seem to contain any "black rays," acting on the photographic plate, while its physiological effects are as striking as those of any other light. If, *e.g.*, the germs of certain plants (peas, lentils, etc.) be placed at 1 to 10 cm. distance from a

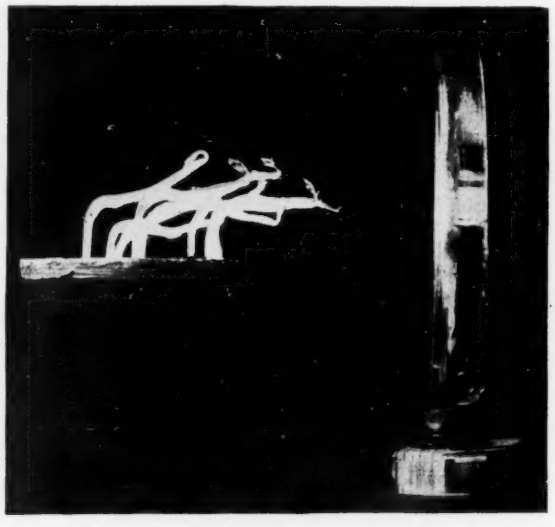

Fig. 5.—Pea Germs attracted by "living" light.

"living" lamp, they are seen during their growth to approach towards the luminous bacteria, two kinds of plants thus attracting one another in virtue of the radiating energy given out by one of them.

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Marine Life Microphotographs.

Fig. 2.—Newly hatched Plaice (*Pleuronectes platessa*).

Fig. 3.—Early post-larval Plaice (*Pleuronectes platessa*).

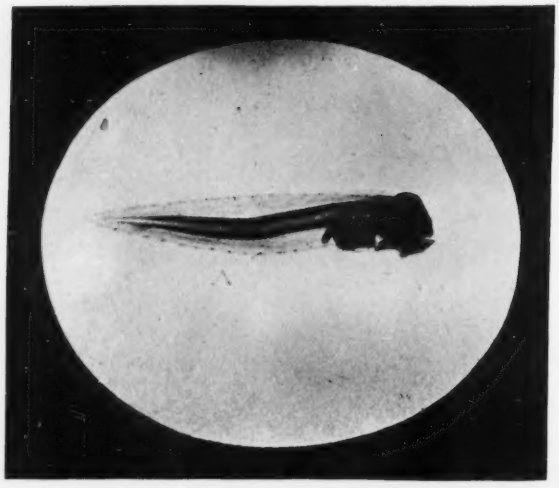

Fig. 4.—Early post-larval Pleuronectid

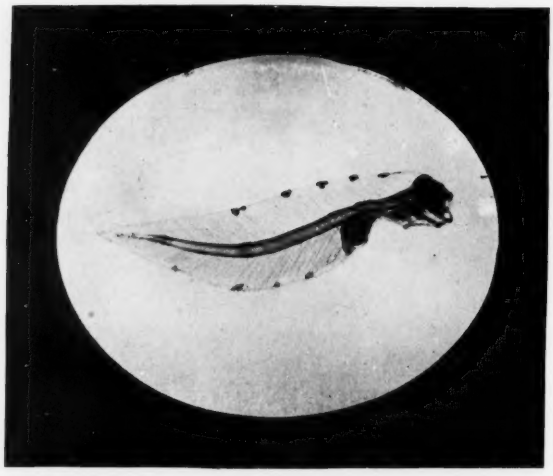

Fig. 5.—Post-larval Lemon Dab (*Pleuronectes microcephalus*).

Fig. 6 —Head of post-larval Lemon Dab (*Pleuronectes microcephalus*).

Fig. 7 – Head of post-larval Turbot.

Studies in Marine Life.

Some Developmental Forms of Marine Fishes.

By G. E. BULLEN.

UNTIL Cunningham, Schmidt, Ehrenbaum, Holt and other ichthyologists commenced investigation of comparatively recent years the early life and development of marine fishes was practically unknown to zoologists. The rapidly decreasing supply of food fishes from such well-known fishing grounds as the North Sea, resulting in the institution of State-supported scientific investigation, has served to lay the foundation to much further knowledge.

When the extraordinary fecundity of certain fishes is taken note of, it may appear somewhat a matter for wonderment that there should be any cause for concern with regard to depletion of trawling areas. The Conger Eel is estimated to spawn as many as eight to nine millions of eggs; the hard roe of the Herring contains not less than twenty-five thousand. But when the various vicissitudes through which the young fish has to pass are taken into account, the necessity for this superabundance of primary units, in the form of eggs, is apparent. Everyone's hand, as it were, is against the young fish in the making. The buoyant type of egg floating at the surface forms food, together with sundry other "plankton" organisms, for shoals of drift fish. And, again, until the *larva* has arrived at a fair size it may fall a prey to fishes which select their food, and also marine birds. Moreover, when the young fish has arrived at an age when, to a certain extent, it is capable of evading pursuit, the fisherman's trawl may sweep it up, though still of unsaleable size. Thus, we may safely conjecture that of every five hundred eggs laid by certain highly prolific species perhaps not more than one adult is produced.

In certain species, however, the eggs and larvæ stand a better chance of surviving, owing to the care of the parent fish. The nest-building habit of the Stickleback is well known to many, as also the solicitude of the male Lumpsucker and Pipefish for the eggs and young, the latter jealously guarding its offspring within a specially-adapted pouch on the lower part of its body until the embryos are of sufficient size to start on the battle of life with some reasonable chance of success. Apart from this parental care, of which there are numerous examples, by a provision of Nature the young of certain species, when they are few in number, are produced fully fledged, as with certain Dogfishes and Sharks. In other kinds of similar type, and also with the Skates and Rays, the undeveloped young are protected by a horny sheath—the "mermaids' purses"—from which they finally emerge well equipped with teeth and fins.

We may, however, pass over further instances of a similar character, as our main consideration is to trace the gradual development of the fish from the egg upward.

Eggs of various fishes differ considerably in size, and in the position and extent of a globule of oil, which, in certain types, is very conspicuous when the specimen is viewed under the microscope.

When this oil globule is of fair size the egg is buoyant, floating at the surface of the water; it is in every respect analogous to the yolk of a bird's egg from which the embryo forming around it derives nourishment (see Fig. 1 A). Unlike the chick, however, the young fish is liberated from the shell before the complete absorption of the yolk into the interior of the body and assumes the form figured in the illustrations (Fig. 1, B, and Fig. 2).

In this condition and until the total absorption of the yolk-sac and certain other minor alterations the fish is termed a *larva* (Fig. 1, C).

A newly-hatched Plaice, a species determinable by the large size of the egg and emerging larva, is shown in the next illustration (Fig. 2). At present the sole means of progression—we can scarcely term it swimming—consists in a broad, simple fin or, rather, fins, running the whole length of the back and the greater part of the lower margin of the body. This is termed the "embryonic fin." It may be well seen in the next few figures (Figs. 3, 4, and 5).

It is very transparent and almost without any substantial support in the form of fin rays, except at the tail. In common with certain areas of the young fish's body, such as the head and stomach, the embryonic fin exhibits the rudiment of coloration. This takes the

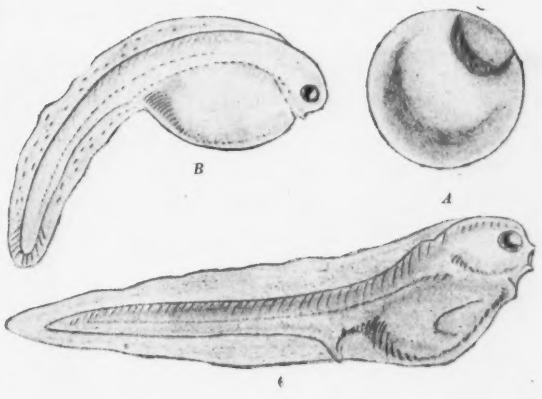

Fig. 1.—A, the egg; B, newly hatched young; C, the same later.

form of star-like dark patches (see Fig. 6), which are termed colour or pigment cells, about which we shall have something to say later. The majortiy of young fishes at this stage have the mouth wide open, the eye is usually very large, and the backbone or notochord is conspicuous. In a number of species the termination of the body, forming the tail, takes a sharp upward curve, a condition known as "heterocercy," a form of construction often met with in fossil forms and least highly specialised living species. This character is well seen in the young Turbot (*Rhombus maximus*) (Fig. 8).

The early development of Pleuronectids or "Flatfishes" is especially interesting in that the newly-hatched *larva* is furnished with an eye on both sides of the head, and presents an appearance similar to the young of a "round" fish. It is agreed that in the case of Pleuronectids we have an instance of what may be termed "wilful distortion." For reasons which are all too apparent members of this order at an early age found it more convenient to swim on the side and bury themselves in the sand, leaving one eye exposed. In course of time the under eye, with a natural tendency to be of some use to its possessor, commenced to move upward to the top of the head, and thence gradually round until it finally took up a position on the other side. But as this adaptation is not normal, despite generations of side-swimming ancestors, the young *larva* continue to show atavistic structure.

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This feature may be observed in the enlargement of the head of a *post-larval* Turbot (Fig. 7), and also in microphotograph of a Thickback Sole (*Solea variegata*) (Fig. 9).

It is, perhaps, unnecessary to add that pigment cells are apparent on both sides of the body in these early stages.

And, speaking now briefly of the deep subject of coloration in fishes, we may, perhaps, be pardoned for taking a sudden digression from these very minute forms of early life, to a point at which the young fish, pleuronectids in particular, have assumed the appearance and structure of adults. In the matter of coloration we have one of Nature's most exquisite provisions for the safeguarding of the growing fish.

The subject has engrossed the attention of scientists for some years past, and, without entering too deeply upon this special study, it may be mentioned that throughout the epidermis of the majority of fishes there occur innumerable cells, each of which is filled with pigment fluid of one or other of the primary colours, together with others, black or white. The cell walls are very thin, and the external surface is capable of

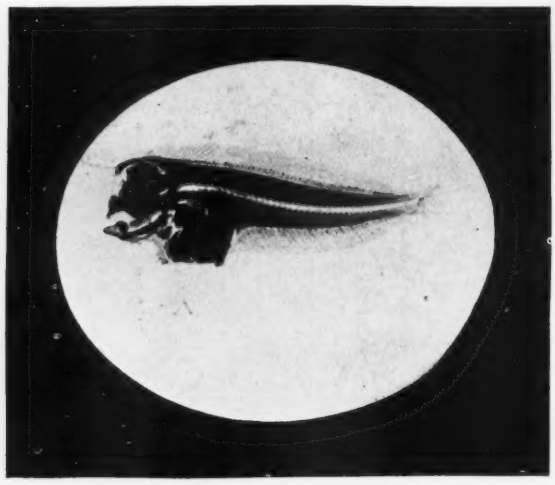

Fig. 8.—Post-larval Turbot (*Rhombus maximus*).

expansion or contraction more or less at will on the part of the fish. It has been ascertained that sight and light play an important part in permitting the voluntary exercise of the muscles of expansion and contraction. Provided with this admirable means of making a quick change of colour, young fishes, Pleuronectids in particular, are capable of adapting their coloration to almost any type of surroundings, another instance of "protective resemblance." To quote an instance in particular—a young Turbot finds itself on a patch of dark sand with here and there a white pebble; by slightly opening up the yellow and red cells, together with a fair number of the black, a dirty shade of brown is the result. But this is not all, for in certain areas of the epidermis all the colour cells are closed down and the colourless or white allowed to open to their fullest extent, the result being that white spots to imitate the stones appear at intervals upon the darker ground in perfect harmony with the fish's surroundings. Some of these young Pleuronectids are remarkably quick in changing colour. The writer remembers an instance of two little Plaice collected from some dark pier piles, almost black at the time of capture, which adapted themselves so completely to the colour of the interior of a galvanised iron pail within an hour, as to be practically indistinguishable.

An ordinary observer, lacking the naturalist's trained eye, may often gaze intently into an aquarium tank with the floor fairly carpeted with flat-fishes without being able to detect a single specimen unless there be movement.

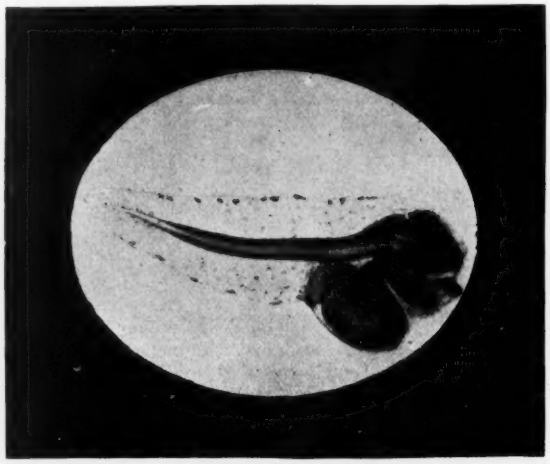

Fig. 9.—Early post-larval Thickback Sole (*Solea variegata*).

But to return now to the main subject. The types hitherto described were furnished with simple embryonic fins. Gradually these sink down on to the body as the permanent fins commence to grow outwards. As this process consists mainly in the gradual formation of fin rays, etc., in a normal manner we need not describe the obvious changes which take place before the *post-larval* form arrives at the "young fish"

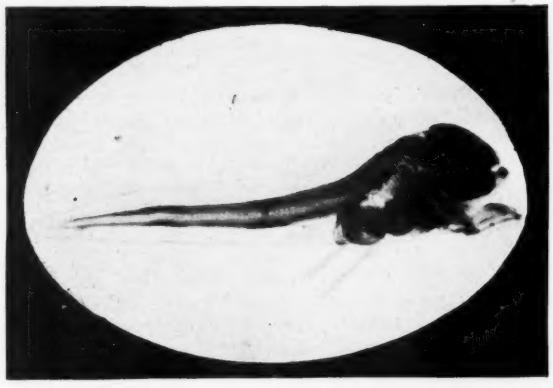

Fig. 10.—Post-larval Ling (*Molva molva*).

stage exhibiting more or less the morphological characters of the adult.

A few interesting exceptions to the general rule may, however, be mentioned. The young Ling (*Molva molva*) (Fig. 10) produces, to begin with, a long pair of ventral fins which gradually forshorten. The Turbot and its allies (Figs. 7 and 8) are decorated with a "top-knot," which subsequently disappears; the young Gurnard has a conspicuous pair of pectoral fins entirely

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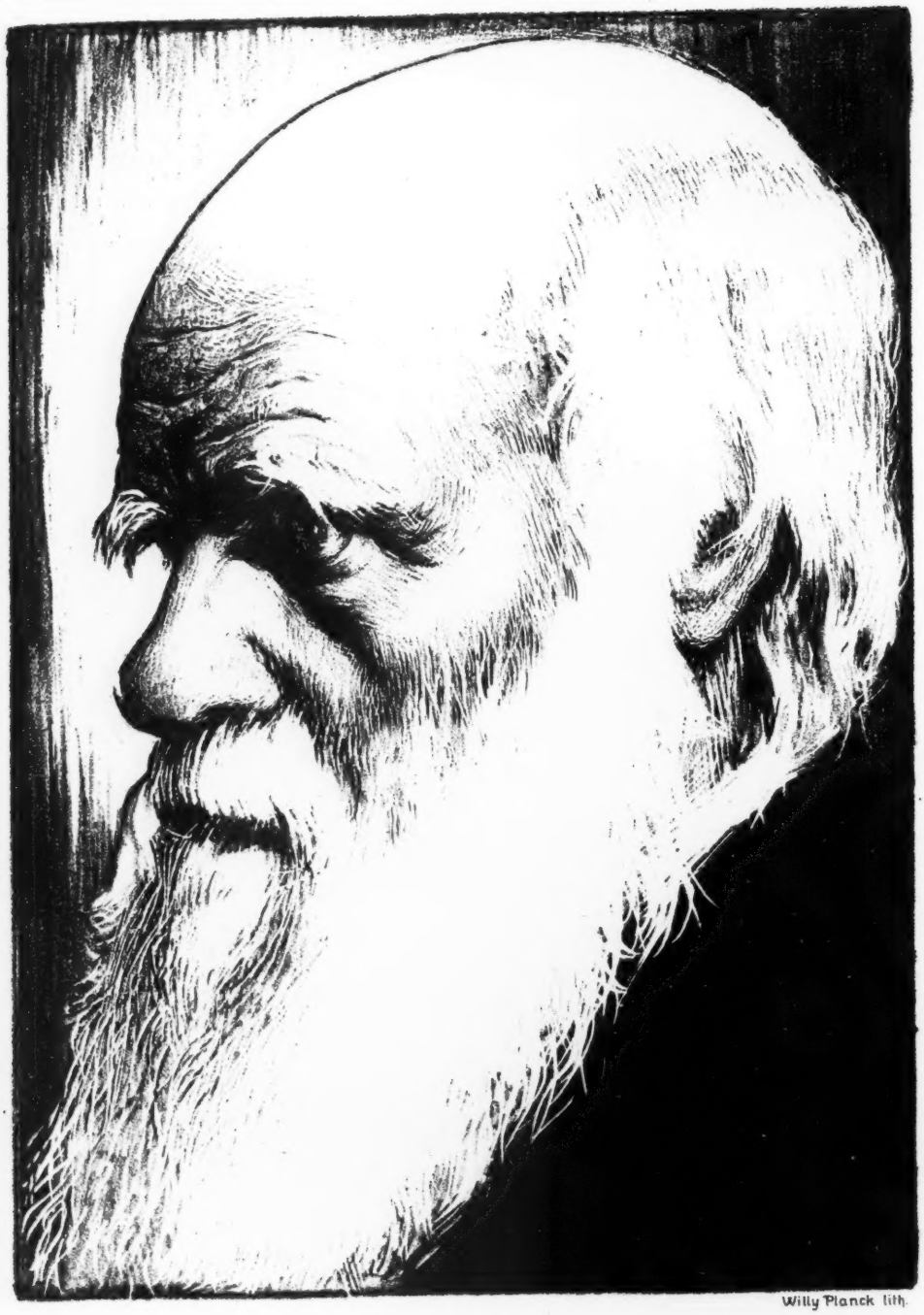


Charles Darwin

out of proportion with the rest of the body; and the Angler (*Lophius piscatorius*) is remarkable in its pelagic stage in being furnished with long filaments to the first dorsal and ventral fins.

Recent investigation into the early development of the Eel by Dr. Schmidt has brought to light evidence of remarkable metamorphosis. Briefly to describe the result of this research it may be mentioned that young eels or "elvers" had often been observed at the mouth of rivers, but no instances of *post-larval* or very small specimens at the "young fish" stage had been recorded.

Two species of fishes generically termed *Leptocephalus* had already been described from British waters by certain earlier writers, and these were considered to be adult forms imperfectly understood from very occasional specimens. By systematic collection of *Leptocephali*, Schmidt first demonstrated that the *larvæ* hatched from the *ova* of eels grew up to a certain age in this form and subsequently reduced in size until the "elver" stage was reached. The *Leptocephalus* has an elongated body semi-transparent and bilaterally compressed, entirely dissimilar in appearance from the parent stock.

The Darwin Centenary at Cambridge.

SOME details of the celebration by the University of Cambridge of the centenary of the birth of Charles Darwin and the jubilee of the first publication of "The Origin of Species" have already been given. It is expected that delegates selected by universities, academies, colleges, and learned societies will arrive in Cambridge on Tuesday, June 22, and that the arrangements for their entertainment, which are, however, subject to alteration, will be as follows: On the evening of the twenty-second there will be a reception, probably in the Fitzwilliam Museum, by the Chancellor. On Wednesday, June 23, addresses will be presented by the delegates to the University in the Senate House. It is hoped to present to each delegate a copy of the first draft of "The Origin of Species." In the afternoon there will be a garden party at Christ's College, where Darwin was a student, and in the evening the University will give a banquet. On Thursday, June 24, the Rede lecture will be delivered, and honorary degrees will be conferred. It is further proposed to hold an exhibition of portraits, editions, and relics of Darwin at Christ's College, somewhat similar to the Milton exhibition of last June.

Already some 200 delegates have been appointed to represent institutions and societies.

WELLCOME'S Photographic Exposure Record and Diary for 1909 (1s. net), in spite of the apparent perfection of previous editions, contains several new and interesting features. The article on Exposure is remarkable for the large amount of definite information condensed into its 28 pages. A very useful list of speed tests of over 80 bromide papers and lantern slides is given, which will be of great utility to photographers who use more than one make of paper or plate for different purposes. The illustrations of various subjects, which have been a feature of the book from its first publication, are now conveniently grouped together on a card carried in the wallet of the book. Other interesting items of the useful contents are the Exposure Calculator, the article on "Photographic Processes," and a "Time and Temperature" card, the latter a valuable companion to the dark room.

The Mechanism of Nuclear Division.

By H. A. HAIG, M.B.

THERE have been many theories put forward to explain the complex processes which take place during mitosis or indirect nuclear division in a cell, but in order to properly approach the subject we must bear in mind that the sequence of changes undergone by the chromatin and other elements of the nucleus is intimately associated with processes both chemical and physical going on not only in the cell under consideration, but also in surrounding cells; in a word the process must be looked at partly from the point of view of the mutual interdependence of cells in a cell-community. This being understood, we are at liberty to proceed to the consideration of the actual details.

Of the influences which are brought to bear upon the nucleus at the beginning of mitosis, there are some which stand out before all others. These are:—

(*a*) The stimulus of certain food materials in solution in the cell-sap; oxygen and water must of necessity be present.

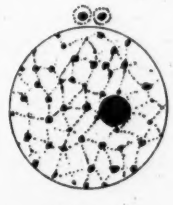


Fig. 1.
The quiescent nucleus, showing nuclear membrane and chromatin-granules arranged on a reticulum of linin. One nucleolus is shown. The two structures lying outside the nuclear membrane are the centrosomes. These latter have been included in the diagram for the sake of completeness although, as stated in the text, they are probably absent in higher plants.

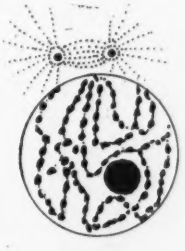


Fig. 2.
Initial phase in mitosis: the amphiaster and astral rays are seen lying close to the nucleus, and the chromatin-granules are being arranged into a definite chain upon the linin threads. Nucleolus still present.

(*b*) A degree of temperature which varies in different plants, but which has certain defined limits. This determines a certain intensity of metabolism.

(*c*) Heredity: Every nucleus in a cell-community having in its chromatic substance portions of both the paternal and maternal chromatin derived from the microspore and the egg-cell nuclei respectively (in plants, that is).

There are, of course, other factors entering into the process, and these we shall touch upon incidentally.

Of the three influences mentioned above (*a*) and (*b*) are essentially of a chemico-physical nature; in fact, many of the phenomena of mitosis may be adequately explained on chemico-physical lines; but we must be careful to bear in mind that we are dealing with substances, viz., chromatin nuclear plasm and nucleolar material (paranuclein), which are intrinsically protoplasmic in nature, and possibly evolved from the cytoplasm by a long series of changes, although in the case of the chromatin we are confronted with the fact that here we have a substance which contains phosphorus (an element absent from the main cytoplasm) which seems to confer upon it some of its peculiarities. This being so, the nucleus, as a specialised portion of the protoplasm, will, to a certain extent, react to the same

stimuli as the main cytoplasm, but, in addition, will manifest certain phenomena consequent on its intrinsic molecular constitution.

To obtain a comprehensive view of the vital mechanism of mitosis we must consider the two cases, viz., one where centrosomes enter into the process, and the other where, after the most careful search, these structures have been found to be absent during all stages. In the former many of the phenomena observed are capable of definite explanation, whereas in the latter there are many details the explanation of which is still wrapped in obscurity.

The centrosomes (see Fig. 1) are bodies which first attracted attention in the animal cell; in the quiescent cell there is often only one of these bodies present, which, as mitosis is nearing, divides into two equal structures, between which a little later arises the formation known as the "amphiaster" or nuclear spindle. Lines and streaks of similar appearance to those of the amphiaster are also to be seen radiating from the centrosomes into the main cytoplasm of the cell, and these are known as the "astral rays." With the progress of research these bodies (the centrosomes) were discovered in the cytoplasm of cells of some of the lower plants lying quite close to the nucleus, but it is at least doubtful whether they are present in the higher plants in ordinary vegetative divisions, although they have been discovered in the Cycads (Zamia), where they are known as the "blepharoplasts" (described by a Japanese observer on the formation of the antherto-zooids).

The origin of these highly interesting bodies is somewhat uncertain; some observers have stated that they are formed from the nucleoli, others, on the other hand, have found evidence that they arise from the linin or possibly the chromatin. It is, however, certain that the centrosomes will take up a chromatic stain, and this seems to give some clue to their origin; but some observers have found that under certain conditions centrosomes and asters may be formed *de novo* from the main cytoplasm, notably in some animal egg-cells, treated with very dilute solutions of strychnine hydrochloride.*

In connection with the mitotic process there seem to be, when centrosomes are present, two main types of formation of the nuclear spindle, viz., one where this spindle arises outside the nucleus but close to its periphery (see Fig. 2); the other where the spindle has an intra-nuclear origin. The latter has been observed by Harper in certain of the Algæ, such as Stypocaulon, and in Erysiphe, one of the Fungi. In animal cells the amphiaster usually has an extra-nuclear origin; in the higher plants, where centrosomes have not been discovered during vegetative divisions, the amphiaster may possibly have an intranuclear origin, but this is somewhat doubtful, as some observers state that it is formed in the kinoplasm, that layer of the cytoplasm which lies immediately outside the nuclear membrane.

However, whatever the origin of this structure, its function seems to be fairly obvious since in the later phases of mitosis the chromatin elements travel along the fibrils of the amphiaster, some of these fibrils acting, on the one hand, according to some observers (Haidenhain), as definite "pulling" agents, or contractile fibres (mantle-fibres). and yet others, on the other hand, being subservient as guiding fibrils (the axial or interzonal fibres).

Another theory remains for us to examine, and that is the "chemotactic" theory, some observers maintaining that the centrosomes act as centres of positive chemotaxis, by virtue of the presence in their vicinity of certain chemical substances having an attractive influence upon chromatin. There appears to be fairly strong evidence for the adoption of this latter theory. It is well known to botanists that the antherozooids of Vaucheria are attracted to the oosphere by means of a substance (probably malic acid) excreted at the apex of the oogonium, and the growth of the pollen-tube in higher plants is doubtless also due to the presence of an attractive substance at the apex of the embryo-sac. We cannot, therefore, dismiss the theory, for the existence of chemotaxis is well proved both in the animal and vegetable kingdoms; but as yet we are, perhaps, arguing more from analogy than from experimental proof, since we have no definite proofs of the existence of an attractive substance in the vicinity of the centrosomes.

Now, speaking generally, although no structure comparable to centrosomes has been found in the higher plants, it has been assumed that the area in the cytoplasm of the cell in the immediate vicinity of the poles of the nuclear spindle possesses activities corresponding

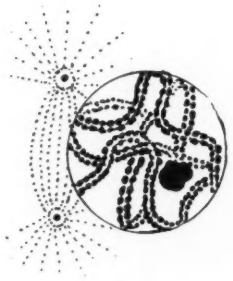


Fig. 3.
The chromatin-granules have here undergone fission, so that two lines of granules now are present. The nucleolus is becoming absorbed and the amphiaster is increasing in size.

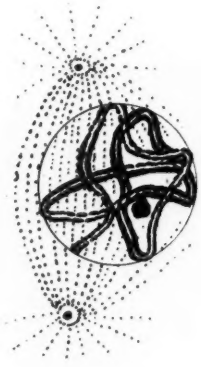


Fig. 4.
A still later phase, showing a complete "spireme"; the fibrils of the nuclear spindle have extended into the interior of the nucleus and the nuclear membrane is gradually disappearing. Traces of a nucleolus still remain.

to those manifested by actual centrosomes. This assumption is no doubt correct, for the phenomena exhibited by the chromatin in the later phases of mitosis differ only in unimportant details from those seen in the case where centrosomes are present. In some cases also, notably in Equisetum, the spindle is multipolar, the mantle-fibres converging in the form of several separate cones to points on a "polar plane" at each end of the cell. There would here seem to be several centres of attraction for the chromatin.

Having now considered the initial phase in mitosis, viz., the separation of the centrosomes (where they are present) and the formation of the amphiaster or nuclear spindle, a phase, moreover, which appears to be of great importance in the animal cell, we come to the discussion of certain other preparatory phases in the process, namely, the changes occurring in the chromatin elements and some other structures in the quiescent nucleus; these changes involve certain peculiar chemical processes and the occurrence of well-defined movements. It must be remembered, however, that, in the higher plants, spindle-formation and the initial changes in the distribution of the chromatin go on hand in hand, and

* See Wilson, "The Cell in Inheritance and Development."

it is very difficult to determine the exact period when the spindle arises, this structure being formed by a more gradual process than in the animal cell. It appears at times that the spindle-fibres seem to push their way into the interior of the nucleus during the earlier phases of mitosis, and this process may possibly be of the nature of ferment action upon that portion of the cytoplasm which constitutes the nuclear "membrane."

The earlier changes to be observed in the chromatin elements of the nucleus consist essentially in the increase in mass and staining power of the chromatin granules and the definite arrangement of these into a skein or thread, which ultimately constitutes what is termed the "spireme"; it is, however, probable that the phenomenon of fission of each separate granule occurs before the completion of this phase (the author's own work on this subject tends to confirm this statement), so that in the completed spireme we may generally recognise a double line of granules very closely set together (see Figs. 2 and 3).

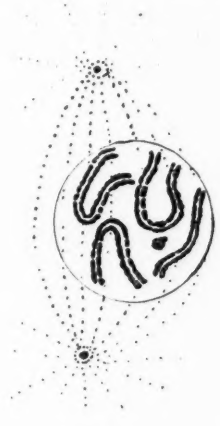


Fig. 3

The spireme has split up into the primary-chromosomes, each of these being double. The chromosomes are being dragged into the equatorial position by the agency of the mantle-fibres of the spindle.

Increase in mass of the chromatin results most probably from the increased capacity of the nucleus at this time to utilise phosphorus-containing food materials (see *supra* [*a*] at beginning of article); but why this increased capacity should arise is difficult to explain, unless we assume that meristematic tissue has an inherent tendency to select certain substances for nutritive purposes.

A fact which can be verified in most nuclei, if different stages are compared with one another, is the gradual disappearance of the nucleoli during the evolution of the spireme phase, so that at the completion of that phase nucleoli are absent. The question naturally arises, what has happened to the nucleolar substance? Has it been transformed into chromatin (to which it is closely allied), or has it simply disappeared, to be worked up by the cytoplasm of the main cell into other substances necessary to the nutrition of the cell at this stage? This point is one which appears obvious, but which is, nevertheless, one of much controversy.

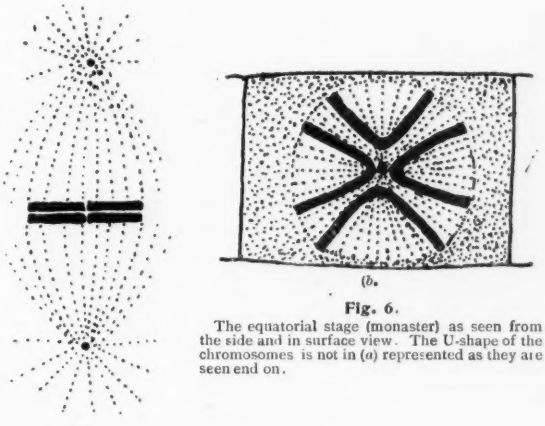
The chromatin-granules, which are arranged into one thread to form the spireme, seem to be drawn together upon the linin-network in a manner suggesting that this linin may have some share in the approximation of the granules—in fact, by contraction of such a network much the same result would be brought about. But such contraction has not been shown to take place by definite observation, and it would be rash to make the assumption without further proof. When fission of the granules occurs, the fission also involves the linin-thread, which splits longitudinally (Mottier, from observation upon Helleborus fœtidus). This early fission of the granules and linin-thread is a fact which has only been discovered in comparatively recent years, and is one of great importance.

By the time the spireme has been completed (see Fig. 4) the granules have increased in size so much that it is often difficult to make out that they are separate and have not fused, but with careful observation under high powers of the microscope we can always determine that the spireme thread is double in nature, and that the separate granules, although very close together, have not actually fused. The nuclear "membrane" has disappeared and the spireme appears to lie in a clear portion of the nucleus, which is, presumably, the clear nuclear plasm, although this is now beginning to be modified, or else is entirely absorbed.

At a slightly later stage we find that the spireme breaks up by transverse divisions into a number of equal "primary chromosomes," each chromosome preserving its dual nature, that is, being split longitudinally (see Fig. 5).

The cause of this breaking up into chromosomes is not at all obvious; it seems that fission occurs at equidistant points, the plane of division passing through a space between two granules, but whether this division is of the nature of chemical absorption or was pre-existent is not certain. Possibly the tensions exerted by the now developing or already developed fibrils of the amphiaster have some influence upon the process.

By the time the spireme is completely segmented the



(*a*.) (*b*.)

Fig. 6.

The equatorial stage (monaster) as seen from the side and in surface view. The U-shape of the chromosomes is not in (*a*) represented as they are seen end on.

fibrils of the nuclear spindle are obvious enough, and in the animal cell are, as a rule, quite a marked feature from the beginning. These fibrils are, as we have seen above, of two kinds, some of them being, according to various observers, of a contractile nature and known as "mantle-fibres," the others, which lie more towards the centre of the spindle, being more of the nature of passive or guiding fibrils (interzonal fibres).

The mechanism which now occurs is a remarkable one, inasmuch as the mantle-fibres appear to have attached themselves to the primary chromosomes, and to drag these (Haidenhain and other observers) into the median equatorial plane of the nuclear spindle, where, finally, each chromosome takes on a definite bent shape, like a U or V, and lies with its bend towards the centre of that plane and its free ends pointing towards the periphery. This is known as the "single rosette" or "monaster" stage (see Figs. 5 and 6).

We see, then, that, according to this theory, the mantle-fibres are of a contractile nature, and are functional in orientating the chromosomes into a definite plane of the cell; the chemotactic theory will not allow of this explanation, and supposes that the centrosomes are the active structures, the spindle fibres being merely passive agents along which the chromosomes travel.

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At a somewhat later period the phenomenon occurs of a more obvious longitudinal fission of the primary chromosomes, or, more correctly speaking, only a further separation of the already formed halves due to tensions exerted by the spindle-fibres. This separation of the two halves takes place along the original line of fission mentioned above, which occurs early during the evolution of the spireme (see Fig. 7). The resulting chromosomes are known as the "secondary" or "daughter" chromosomes, and soon travel away from one another. (In some cases what is known as "heterotypical" mitosis occurs, where ring-shaped chromosomes are formed instead of U or V-shaped ones.)

The secondary chromosomes, according to the contractile theory, are now drawn apart (see Fig. 8) by means of the mantle-fibres until the two sets of loops come to lie at opposite poles of the cell. When this stage is reached the work of the spindle-fibres is at an end so far as their action on the chromosomes is concerned.

The mitotic method of nuclear division is, as we see,

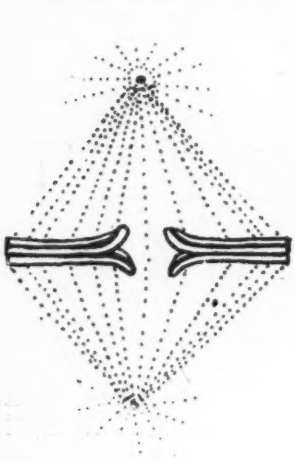

Fig. 7.
Diagram showing the manner in which the two halves of e ch chromosome separate from one another. The mantle-fibres are indicated as being attached along the whole length of eacn half of a chromosome.

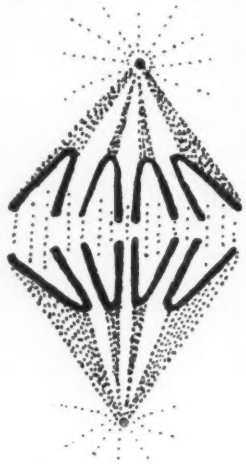

Fig. 8.
The secondary chromosomes being pulled away from each other in two systems of daughter-chromosomes. Separate cones of mantle-fibres are indicated.

a highly specialised one, and one which enables a very accurate and equal re-distribution of the chromatin to be made; "amitosis" or mass-division of the nucleus occurs in some animal and plant cells, but is to be looked upon in many cases as an evidence of degeneration or adaptation to altered conditions of existence. One observer succeeded in changing the mitotic method into the amitotic one in the case of Spirogyra by growing the filaments of the Alga in water in which a trace of ether was present—a very interesting experiment, showing that at least in this low order of plant adaptation to altered conditions was possible by gradually altering the nutrient medium. In the higher plants, however, mitosis seems to be a very constant method of nuclear division, and, as far as experiment yet shows, cannot be easily altered to amitosis, although the latter does occur in Cambial cells and in some other instances.

The mechanism of the final stage of mitosis is as yet imperfectly understood; when the daughter-loops have reached opposite poles of the spindle (diaster-stage) there is apparently a short period of quiescence and then "involution" occurs, whereby the loops join up again to form a spireme at each end (dispireme stage). The daughter-spiremes then undergo fission and division into chromatin-granules once more, these latter being ultimately distributed upon the linin-network to form a typical nuclear reticulum (resting stage). Shortly after this in plants the cell-plate is formed, and, finally, this is converted into a cell-wall of chemically pure cellulose.

The stages in the so-called "metaphase" of mitosis are extremely interesting; the dragging apart of the secondary chromosomes by means of the mantle-fibres is, according to later researches, not altogether hypothetical, since the two halves of each primary chromosome are certainly attached, probably along their whole length, to separate cone-shaped bundles of mantle-fibres. This the author has verified in the case of Allium and Hyacinthus, and we have mentioned the fact that in some cells the nuclear spindle is multipolar.

It would seem, however, that we must combine the two theories, viz., the contractile and the chemotactic, in order to explain the mechanism, and even then we are left in doubt as to the nature of the attractive influence supposed to emanate from the centrosome area; moreover, the chemistry of the earlier phases is as yet very obscure, and, as I have mentioned at the beginning of this article, the question of an hereditary influence must be considered. These few remarks may, however, serve to emphasise the extreme complexity of a subject which has been, perhaps, the cause of more controversy than any other problem of cytology.

(The diagrams illustrating the article have been compiled partly from photo-micrographs and microscopical observation of growing tissues of *Allium*, *Hyacinthus*, and *Lilium Martagon*.)

References: Wilson.—"The Cell in Inheritance and Development."
Campbell.—"University Text-book of Botany."
Campbell.—"The Cell."

A Simple Electric-Influence Machine.

By CHARLES E. BENHAM.

THE illustration shows what is, perhaps, the simplest form of electric-influence machine. The two vertical glass strips, A and B, are 13½ inches by 3½ inches, with holes drilled through them at H H′. These holes can be pierced with an ordinary steel drill, using turpentine as a lubricant and exercising patience rather than pressure. On the face of each strip is a piece of tinfoil, cut as shown. The tinfoil must be narrowed at one end, so that it can be passed through the hole and fastened to the glass on the other side. Metal brushes, passing through the centre of a thin slice of wood or cork, are secured with glue to that side of the glass, the centre of the cork being over the hole, so that the brushes project and yet are in contact with the tinfoil on the face. The brushes touch the back of the revolving disc C, which is 9 inches in diameter and about half an inch behind the inductors. On the other side of C are twelve sectors of tinfoil, which are touched by the earthing brushes, D D′, and when the disc is revolved from left to right by means of pulley and spindle each inductor will be electrified with an accumulating charge of opposite electricities. Suppose at the outset A has an infinitesimal charge of plus electricity, the sectors as they pass D will take up a negative charge, and will give it to B as they pass the collecting brush at H′. B being thus negatively electrified, will charge the sectors at D′ with positive electricity, which, in

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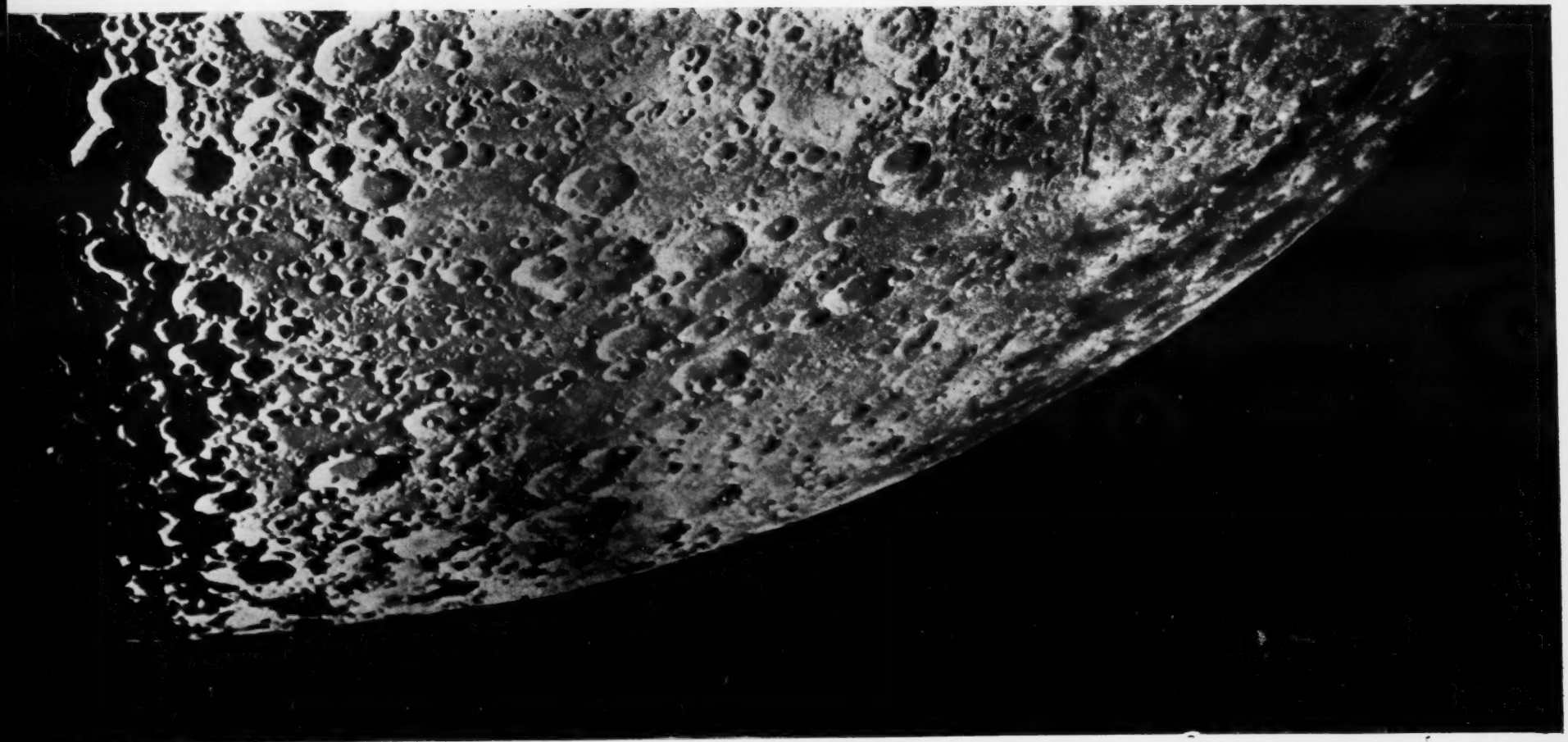
PART II.



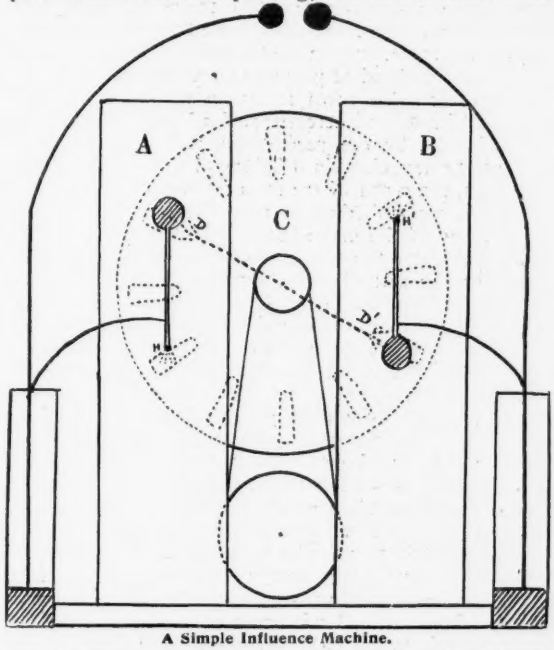
Reproduced by kind permission of the Directors of the Paris Observatory.

The Moon.

The lower portion of the first quarter.

turn, will replenish A by the collector at H, and so there will be a constant accumulation at compound interest of opposite electricities in A and B. Discharging rods and condensers being connected with the inductors a steady stream of sparks will fly between the terminals. The machine is quite self-starting, and, in principle, somewhat resembles a Voss, except that the inductors connect direct with the dischargers, and that the replenishing brushes take their charge from the back of the disc instead of being brought over to touch the sectors on the other side—an unnecessary complication which might well be abandoned in the Voss, as the replenishment is just as effectively carried out from the plain side of the disc.

All the glass parts must be carefully varnished, and it may be pointed out that the usual practice of employing shellac dissolved in methylated spirit for this purpose is a mistake. Though this varnish is almost invariably used for electrical instruments it would be difficult to find a more unsuitable one. It is highly perishable under the sparking, and soon seems to lose its insulating properties more or less. No spirit varnish should ever be used. A good hard body varnish, the solvent in which is oil, takes longer to dry, but its insulating properties and durability are incomparably superior, and are well worth the time required for the drying. Both sides of the disc and the glass strips should be coated with this varnish, which will dry in about two days, or in less time in a warm place.



A Simple Influence Machine.

A and B inductor strips of glass bearing strips of tinfoil on the side towards observer. Holes are drilled at H H', through which metallic brushes, connected with the tinfoil, pass and touch the back of the disc C, which has tinfoil sectors on the other side. Earthing brushes D D' touch the sectors as they pass the inductors. The inductors are connected with discharging rods and Leyden jars.

Like the Voss, this machine is liable to reversal, and an equally curious problem applying to each machine is the limitation of its power. It would seem, theoretically, that on the principle of a charge accumulating at compound interest the electrification should speedily grow until the spark at the terminals would leap any interval less than that from one inductor to another. But with a disc of 9 inches diameter it will not be possible to get a spark of more than about 2 inches, and it is clear that, though at first the charge accumulates at a very high rate of increase, something operates to diminish that ratio after the accumulation has reached a certain point. Leakage, of course, has to be considered, but this is not by any means sufficient to account for the evident falling off. The explanation is extremely simple, but it seems to have been overlooked, for it has never been set forth in any of the works dealing with the subject of influence machines.

Consider for a moment the condition of the sector at D. It is, as has already been said, under the inductive influence of A, which we will suppose is positive, giving the sector a negative charge. But after the machine has been started the sector is also under the counter-influence of the adjacent glass and sectors of the disc itself, which are negatively electrified, and tend to charge the earthed sector positively. At the starting of the machine this counter influence is not present, but as the plate gets more and more charged it asserts itself more and more, and so the influence of the inductors proper is obviously more and more counteracted by that of the disc itself upon its own earthed sectors, until a limiting equilibrium is reached, and a higher charge cannot be accumulated. This explains why spark length is actually reduced by an increased number of sectors, as then the induction of the neighbouring sectors is more potent on the one that is earthed. No sectors at all need be used except to ensure self-excitement and to avoid the friction of large brushes.

The same consideration also explains why, after a discharge at strain, or any sudden and complete discharge of the inductors, the machine usually reverses. The discharge of the inductors leaves the undischarged glass disc free to exercise its influence unopposed on the earthed sectors, which are, consequently, reversed in sign. Almost the only static machine practically free from reversal is the Wimshurst, in which this self-induction of the disc is minimised by the fact that the two discs keep each other's electricities "bound," and, consequently, inoperative except near the collectors, where they are too remote from the earthing brushes to effect reversal by induction.

The remedy, therefore, for reversal in the Voss, or in the machine described above, would appear to be some attachment which would keep the electricity of the charged disc latent until it reaches the collectors. This might, perhaps, be effected by ensuring that the portion of the disc immediately in front of the earthing brushes is faced by a condensing plate, earth-connected, but insulated against receiving any charge by transfer from the disc. If this could be contrived, the reversal trouble might be got over, and probably the general efficiency of the machine might be considerably increased.

An Atlas of the Moon.

WE publish with the present number of "KNOWLEDGE" the second of a series of large-sized plates of the moon. These plates are made from the magnificent photographs of the moon which are the work of MM. Lœwy and Puiseux, of the Paris Observatory, from which they have been taken by special permission. We also desire to acknowledge our indebtedness to the Royal Astronomical Society, who have been kind enough to place their photographs, together with every facility for reproducing them, at our disposal. The series of plates will number twelve in all, and, when completed, they will form an atlas of the moon. This, the second section, is a third part of the first quarter.

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Professor Nipher's Electric Experiments.

THE experimental work of Professor Nipher at Washington University on the nature of electric discharge is still making progress. He uses an eight-plate static machine, which may be driven by hand or by a motor. Sparks from 4 to 8 inches long are taken from the two terminals into parallel conductors having high resistance. These resistances consist of long, thin strips of cloth moistened with salt solution. These lines spark to ground contacts, which are about 50 feet apart, in the yard outside.

A thin wire is bent into a series of sharp right angles. This wire may be looped into either the positive or the negative line. Photographic plates enclosed in hard rubber holders are placed at these angles. Some of them are exposed to the wire on the ground side of the angle, and some on the machine side. Their distance must be so adjusted that they give symmetrical results when the spark discharge around the angles is reversed.

With the negative discharge the plates on the ground side of the angles are much more strongly fogged than those on the machine side. Negative electrons having a mass of about 1-1,000th of that of the hydrogen atom leave the wire at the angle, because they cannot turn the corner. They pass on through the cover of the hard rubber holder, which may be 3-16ths of an inch thick, and fog the plate, which is developed in the ordinary way. These particles have momentum. They have energy of motion. They are a component of matter.

These particles also produce sharp shadow pictures of any thin object, like a microscope slide, lying on the photographic film.

When the wire having these angles is looped into the line from the positive side of the machine this effect is also observed, but it is very much feebler. With a cover to the holders 1-16th of an inch thick, 9,000 spark discharges in the positive line produce about the same intensity of image as is obtained with a single spark in the negative line. And here the effect is vastly stronger on the machine side of the angle than on the ground side. The negative electrons are, therefore, doing the work in the positive line also. They flow through this line from the ground to the machine. But they are not forced in under pressure, as they are forced out from the machine on the negative line. It is these little particles of negative electricity which constitute the electric current. They have kinetic energy which they impart to the conductors through which they are beating their way. In an arc light they plunge across from the negative carbon to the positive carbon. Their impact upon the positive carbon results in the formation of a crater which is intensely heated. About 85 per cent. of the light comes from this crater in the end of the positive carbon, which is, as has long been known, more than 1,000 degrees Centigrade, or 1,800 degrees Fahrenheit, hotter than the negative carbon.

Professor Nipher calls attention to the fact that the electro-magnetic action of these electrons on each other in a non-oscillating discharge is sufficient to account for the thinning out of the sparks towards the positive end of the spark. This is seen both in the negative and in the positive line.

Anthony Van Leeuwenhoek, the First Bacteriologist.

By DAVID FRASER HARRIS, M.D., B.Sc. (Lond.), F.R.S.E.

THERE were two great workers with the microscope in the latter half of the seventeenth century—the Italian, Malpighi, and the Dutchman, Leeuwenhoek. Of these the former was, in his own time and is still in our day, by far the better known man.

Malpighi was the father of such as work with the microscope; the creator of Histology everywhere, not merely of Italian, the father of both the Histologies, vegetable and animal. Much of his life was spent in Bologna, the old-world, arcaded, sun-bathed city—the seat of a University founded more than 800 years ago.

But very different was the place to which I made a pilgrimage in the Christmas holidays of 1907—the commonplace and obscure little town of Delft in Holland, if known in more than name to the great mass of my countrymen, known as the seat of the manufacture of a certain kind of pottery called "Delf."

Though the little town is by no means devoid of interest, all its other interests are for biologists thrown into the shade by the recollection that this was the scene of Leeuwenhoek's life-long labours with the microscope, the place where the first bacteriologist was born, lived, worked, died and was buried. The town is on the line of the canal between Rotterdam and the Hague. Modern the place certainly is not; it was founded at the end of the eleventh century by Duke Geoffrey of Lorraine. In the palace or Prisenhof, William of Orange was assassinated in 1584; in the old church, or Oude Kerk—as old as the town itself—two of Holland's naval heroes, van Tromp and Piet Hein, lie buried.

Its New Church, founded in 1381, is the last resting place of a most important person in the history of European theology, Hugo Grotius (Groot). Here, too, is the family tomb of the Princes of Orange. In 1654 there occurred a disastrous gunpowder explosion in which upwards of 1,200 inhabitants perished.

Delft is best known for its pottery, but this industry is almost extinct, the present manufactures being carpet-weaving, distilling, and dyeing. There is some life in the little place, for it has a polytechnic school, a school of military engineering, a school for the education of Colonial civil servants, a school of design, a theatre, and a lunatic asylum. The town, which is built in the form of a square, is rather gloomy, and its narrow streets, flanked by high houses, have stagnant little canals in the middle of them.

Such was the place at which we alighted from the Rotterdam train in the grey light of a January afternoon. Our fellow passengers stared as we left the carriage; they could understand our going on to the Hague, but *what* was there to detain an Englishman at Delft at that time of year?

Only interest in the history of Biology could make one search out the ponderous Oude Kerk to view the tomb of a man whose very name is an unknown sound to all save a few. *We* knew, however, that in that ungainly old church towering over the crowded houses lay buried an indefatigable worker in Nature's invisible world, one whose greatest honour in life was, as it is the boast in the inscription on his tomb, to have been enrolled a Fellow of the Royal Society of London, or "of England," as it puts it.

The F.R.S. told Leeuwenhoek in his lifetime that he had not lived in vain. We know from the good work he did that, whether he had been made an F.R.S. or not, he belonged to the innermost circle of the scientific immortals. This F.R.S. was, perhaps, *the* one great event in a life devoid of incident, at any rate empty of anything like the incidents that filled Malpighi's.

Malpighi, for whom a chair was created by a Grand Duke and he a Prince of the Medici, who was *invited* to teach in the University of Messina, and then entreated to leave it for the chief Professorship of Medicine at Italy's premier University of Bologna, who was constrained to end his days in the elegant sinecure of physician to the visible head of Christendom, and who was an F.R.S. to boot—even his life has been described as devoid of incident! What, then, must be said of Leeuwenhoek's? Leeuwenhoek probably never left Delft; it is doubtful if he ever quitted Holland. That Leeuwenhoek was a person of some consequence may be incidentally gathered from his having been made curator or trustee for the widow of Jan van der Meer the painter who was born at Delft in 1632 and died in 1675.

Malpighi was an hereditary landowner, Leeuwenhoek began life either as a linendraper's assistant or a glass-grinder's. He worked all his life in the little town where he was born, and seemed content to know that not only his countrymen, but those generous men of science in the greatest city of the world had recognised his worth. Science had equal need of the landowner and the linendraper.

We were not long in finding the Oude Kerk, nor the venerable guide inside it. He was dressed entirely in black, and wore a black skull cap. He immediately directed us to the tomb of van Tromp; of course, that was what the Englishman had come at such a time of year to see. Casting a passing glance at the elaborate marble sculptures on the gilded cenotaph of the hero, I pushed on saying, "Any light is good enough to see van Tromp's tomb by, let me see Leeuwenhoek's before the dark." To the latter, accordingly, the reverend guide led us correcting meanwhile my pronunciation of the name. At last, then, we stood before the only monument besides his discoveries that keeps the name of the great Dutchman alive on earth, and it was erected, we found, by "his sorrowing daughter" not by any admiring strangers whatsoever. As a monument it is plain and even severe, while its setting in that huge, cold, white-washed northern, church is very cheerless. Not that it was exactly neglected; some hand had placed a wreath upon it not many weeks before. The long inscription is carved on a high, narrow slab of very dark stone—marble or granite—over which is placed a portrait medallion of Leeuwenhoek which thus stands out effectively; it represents the left profile under a full wig. Below the slab is an ornamental pediment of dark stone with another inscription, and above this a marble skull appears quite out of place but inserted there by the conventional, gruesome taste of mortuary lapidary art prevailing at that time.

Perched on the high slab is a marble urn surmounted by a gilded torch, while on the white wall behind a single arch or vaulting springs from two very unpleasing pilasters. From the summit of the arch a female face in white marble looks down on the tomb; a peculiarly ugly black iron railing surrounds the monument. The inscription is cut in clear lettering. The sense of it is as follows:— "Erected to the pious and everlasting memory of Anthony van Leeuwenhoek, member of the Royal Society of England, who, by the help of microscopes which he had himself made, scrutinised the most hidden things in Nature, and thus by assiduous study learned the secrets of the physical world. These wonders he described in his native language for the instruction and admiration of the whole world. Born at Delft, October 24, 1632, died there August 26, 1723."

Another inscription states that "this monument is erected to her very dear father by his sorrowing daughter, Maria a Leeuwenhoek." Her own tomb is marked by a very deeply incised stone in the pavement to the left of the monument. These very deeply cut stones in high relief are a feature of the floors of Dutch churches; it makes walking over them quite difficult and even hazardous to the unobservant.

In the printed account of the monuments in the church we are informed that Van Leeuwenhoek's friend the Dutch poet, H. C. Poot, who, in some respects, is to be compared with the famous Scottish bard, Robert Burns, honoured his memory with the following epitaph which is carved in the freestone block at the entrance to the grave:—"Here lies Anthony van Leeuwenhoek, oldest member of the Royal Society of London; born in the town of Delft on 24th October, 1632, and died on the 26th of August, 1723, at the age of 90 years, 10 months, and 2 days.

"If, O wanderer, respect for great age and wonderful gifts is universal, then guide thy steps with reverence here, for here hoary science in Leeuwenhoek lies buried."

Once more one could not help comparing the tombs of the two great contemporary microscopists of the 17th century. How different their last resting-places; here an air of chilliness, gauntness, vastness, cheerlessness, massiveness prevades the place; so different from the colour, the brightness, the gaiety and the tinsel of the southern church of St. Gregory. Here the unlovely solidity of the Dutch Reformation, there the thoughtless superstition of Roman Catholicism. Of course we returned to pay our respects to the great van Tromp, as we would not on any account have hurt the feelings of our grave and courteous cicerone who sold us a printed account of the tombs in his church and an amateur photograph of Leeuwenhoek's monument, about as bad an amateur photograph as I have ever seen, and that is saying a good deal. There being nothing else to detain us, we stepped out into the dark of the winter evening. Here, then, within a few hundred yards of one another lie three of Holland's great men—van Tromp, Hugo Grotius, and van Leeuwenhoek.

A hero of Holland's naval wars, a hero in Holland's religious struggles, and a hero in the peaceful, silent conquests of science in the world of the "infinitely little." But whose work remains? What have we of van Tromp's to-day? We have his memory in naval history, and how it was his guns that made London quake and that turned old Albemarle down to the mouth of the Thames to reply to them; we have this gorgeous mausoleum in Delft, and we have the popular song beginning—

> "Van Tromp was an admiral brave and bold,
> And he walked beside the sea;"

but I do not know that we have much else. And what remains of Grotius, in his lifetime the world-read Arminian theologian? Under the dust of our libraries rest his treatises on Divinity, International Law, Political Liberty, and Dutch History—and of Leeuwenhoek?—the whole science of Bacteriology. Leeuwenhoek was

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the first human being to see a bacterium and a micrococcus, and those he first described were scraped from his own teeth. It was to the Royal Society of London that this discovery, fraught with such consequences to medicine, was announced. The Royal Society has been at the birth of a good deal that has moulded humanity.

The passage first announcing this discovery is in a paper, "Animals in the scurf of teeth," dated September 17, 1683, and published in Vol. XIV. for 1684 of the *Phil. Trans.*: "Besides these animals there were a great quantity of streaks or threads of different lengths, but like thickness lying confusedly together, some bent and some straight. These had no motion or life in them" (evidently Leptothrix buccalis). He had just described some motile protistæ which he had killed by rinsing his mouth out with vinegar.

Of course Leeuwenhoek was not what we *now* mean by a bacteriologist; bacteriology began with Pasteur; but scientific microscopy owes a great part of its existence to the Dutchman who ground his own lenses and left a cabinet of 26 of them to the Royal Society which has lost them.

Baker in his treatise on the microscope says that Leeuwenhoek's lenses were not spheres or globules, but double convex lenses, with magnifying powers ranging from 40-160 diameters.

According to Professor Stirling, the microscopes used were still of the type of "simple microscope," high as the magnifying powers were which he reached with them. "Each consisted of a small biconvex lens placed in a socket between two plates of brass, which were riveted together and pierced with a small hole opposite the lens. The object to be examined was fixed at a convenient distance and its focal distance adjusted by screws." "His capital discovery was undoubtedly that of the capillary circulation of the blood first announced in 1690," says W. B. Carpenter in the *Encycl. Brit.* (Vol. XIV., p. 411).

Now, if this means that Leeuwenhoek's discovery of the blood moving in capillaries was the chief thing he saw under the microscope, it is possibly true from a physiological, although not from a morphological, point of view. But Leeuwenhoek was not the first to see the flowing blood in a capillary; exactly thirty years before (1660) Malpighi in Bologna had seen that in the frog's lung. Leeuwenhoek thus discovered the capillary circulation for himself, but not for the scientific world which had been informed of it through a letter from Malpighi at Bologna to Alphonso Borelli at Pisa. But the correct date of Leeuwenhoek's seeing it for himself for the first time is 1688, or 28 years after Malpighi.

I have before me an English translation of Leeuwenhoek's classic: "The true circulation of the blood, and also that the arteries and veins are continued blood-vessels clearly set forth, described in a letter written to the Royal Society of London by Antoni van Leeuwenhoek, member of this same Society." The letter is dated September 7, 1688, and as he says that the observations that led to it began with his finding frogs' eggs in May of that year, there is no doubt whatever that it was between May and September, 1688, that he saw living capillaries in the tail of the tadpole, the tail of the fish (stickleback), and the web of the frog's foot. He virtually verified and extended Malpighi's discovery without apparently knowing anything about Malpighi's work. He does not mention him in this paper. I do not think he had seen any of his writings or even heard of him. Delft was intellectually in a backwater, and for long after 1688 scientific news did not travel very fast.

True, Delft is not far from the University town of Leyden, but it is doubtful if there was one microscope in the whole University at that time. There must have been one in the town, for a student, Ludwig Hamm, discovered spermatozoa by means of one—a discovery which Leeuwenhoek also made independently of Hamm; but by 1688 the time had not come for the introduction of physical methods into the study of medicine in the class-rooms of Leyden—that was left for Boerhaave, whose discourse on "The Use of the Mechanical Method in Medicine" was given at Leyden in 1703, as the inaugural address of the third year of his professorship.

Leeuwenhoek does, however, allude to his countryman, Swammerdam, whom he quotes on the morphology of tadpoles. In this passage we find that Swammerdam alludes to the "incomparable Dr. Harvey's anatomical descriptions."

The late Sir Michael Foster, in his truly admirable book on "The History of Physiology in the 16th, 17th, and 18th centuries," gives the date of Leeuwenhoek's seeing capillaries as "1668" (p. 98); the second "6" may be a misprint for "8."

Although Delft was not a University town, and Leeuwenhoek not a University man, and not in this way brought officially into contact with men of science, yet he happened to have as scientific confrere a young physician of considerable anatomical attainments—Regner de Graaf. This was no other than the discoverer of the ovarian follicles since known as "Graafian." and the author of a treatise on the pancreatic juice. In 1673, the year in which de Graaf died, he introduced Leeuwenhoek to the notice of the Royal Society to the fellowship of which he was elected in 1680. Leeuwenhoek contributed a large number of papers to its Transactions which may be seen in Numbers 94 to 380. His first letter to the Secretary Oldenbury is dated 1674.

As regards the red blood corpuscles or erythrocytes, Leeuwenhoek, although not the first to see them, was certainly the first, recognising what he saw, to describe them correctly as circular in man and oval in the vertebrata below man. As early as 1674 he gave an account of these bodies in the Philosophical Transactions. But Jan Swammerdam (1637-1680), in 1658, had seen erythrocytes in frog's blood and correctly attributed the redness of the blood to these and not to the plasma. This observation was not published until 1738 by Boerhaave in the *Biblia Naturæ*.

Malpighi, in 1665, published an account of adipose tissue as he had seen it in the omentum. He described what he took to be fat-cells in the capillaries of the membrane: they were really erythrocytes. Thus as Swammerdam's observations were not published, and Malpighi's, although published, erroneous even if accessible to Leeuwenhoek, we may in a certain sense give Leeuwenhoek the credit of priority of discovery in this matter.

It was, indeed, by the presence of these cells in the blood that Leeuwenhoek could see that it moved. It is interesting to note that he is entirely Harveian in his conception of the circulation. He writes: "I could distinctly perceive the whole circuit of the blood in its passage to the extremities of the vessels and in its return to the heart." Quite recently there has been published a reprint of Leeuwenhoek's classical paper; it is one of such in a work entitled "Opuscula selecta Neerlandicorum de arte medica" and is accompanied by facsimiles of his original illustrations of the tadpole and stickleback, and has an English translation on the

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opposite side page for page. Along with it goes what seems an excellent portrait of Leeuwenhoek. It represents him in a full wig seated at a table, lens in hand.

As to the circulation of the blood, of course there were unbelievers; each new thing has had them. Perhaps one of the most curious paragraphs of Leeuwenhoek's paper on the circulation is the last, in which he enumerates for the benefit of the Society three respectable men who had witnessed the capillary circulation. He says that people had remarked: "Must we believe it because Leeuwenhoek tells us?" and so he is going to produce eye-witnesses. "But now that I hear that more credit will be given to my words when I mention the names of those who have partly seen the aforesaid circulation of the blood about which I write to your honourable Society, and which I have discovered, I have no objection to mentioning instead of many, such as I trust will deserve most belief, as, for example, Mr. Cornelius Gravesande, M.D., and ordinary professor of anatomy and surgery, and also councillor and late sheriff of this town; Mr. Cornelius Valensis, also councillor and late sheriff; Mr. Antoni Heinsius, LL.D., councillor and 'pensionaris' of this town, late Envoy Extraordinary to His Majesty the King of France, and not long ago Ambassador of this State to the Court of His Royal Majesty of England. To these gentlemen, to whom I usually communicate many of my discoveries, I have also shown the true circulation of the blood as distinctly as we see the current of the water in a running river with our naked eyes." From this we see that Leeuwenhoek entirely believed himself to be the discoverer of the capillary circulation. Perhaps the best known man who ever looked through a lens of Leeuwenhoek was the Czar, Peter the Great. He passed through Delft in 1698 and asked the man of science to visit him and bring his microscope with him. It is said that the Czar was much impressed by the spectacle of the circulation in the tail of a small eel.

In human histology Leeuwenhoek described the dentinal tubules, the fibres of the crystalline lens, the medulla of the hair shaft, the epidermis, the spermatozoa, and a very great deal else. Leeuwenhoek was undoubtedly the first to give anything like a systematic account of the finer structure of insects, he described the scales on the wings, the tracheæ, and the claws and appendages of spiders. He noted that the eyes of insects as well as of crustacea are facetted or compound. Besides giving a full account of the anatomy of the flea (*Pulex irritans*), he studied its development showing that it did not arise from sand, dust, or dirt as was variously held in his day, but that it arose from an egg, like every other creature he knew, and passed through a metamorphosis. He remarks that "This despised creature is endowed with as great perfection in its kind as any large animal."

He observed that the pupa of the flea was attacked and fed on by a minute parasite. Jonathan Swift, having got hold of this fact, made use of it in the following clever but now hackneyed lines:—

> "The vermin only tease and pinch
> Their foes superior by an inch.
> So naturalists observe, a flea
> Has smaller fleas that on him prey,
> And these have smaller still to bite 'em
> And so proceed ad infinitum:
> Thus every poet in his kind
> Is bit by him that comes behind."

("Poetry, a Rhapsody," 1733, Vol. XIV., p. 311, Works of Swift, Scott's Edition.)

It was Leeuwenhoek who first gave a satisfactory account of the Aphides and the stages of their development. He showed that what had been called "ants' eggs" were the pupæ of the Aphides, that the real eggs of Aphides were far smaller and underwent development into larvæ. W. B. Carpenter thinks that Leeuwenhoek was the first to see a Foraminifer, when in the stomach of a shrimp he found what is now called Nonionina. He gave excellent figures of Balanus. He discovered Rotifers and gave an account of their surviving desiccation.

Leeuwenhoek by no means neglected *vegetable* physiology, for he investigated the structure of oak, elm, beech, willow, and fir, noting the "pitting" in conifers and giving an account of medullary rays. He has left accurate descriptions of the embryo in germination and its relation to the Cotyledons. He also dealt with the general anatomy of fruits and seeds; he was the first to discover "pitted vasa in secondary wood," and the first also to see crystals in plant tissues in the rhizome of the Iris.

The Franklands, in their life of Pasteur, state that Leeuwenhoek in 1675 discovered yeast-cells in the deposit under a fermenting liquid. Outside biology he wrote on the forms of crystals, of sugar in particular, and on the microscopic appearance of the edge of razors. He has left directions as to how to hone them for shaving.

One feature in Leeuwenhoek's work which does not seem to be so widely known as it ought to be is his battle against the all-prevailing superstitions of his time as regards "spontaneous generation."

It is difficult for us at the present day to realise the depth of darkness and confusion amid which men's minds worked in the 17th century with regard to the subject of generation. The Cochineal insect was supposed to be "the fruit of some tree," the putrefaction of the carcase was supposed to engender maggots, the putrefaction of meat to give rise to flies, insects found within galls were supposed to have arisen from the tissues of the tree—even the otherwise enlightened Redi thought this—the flea was believed to be bred of corruption in dust or sand, etc., marine molluscs were imagined to be produced from marine mud, and eels were supposed not only by the vulgar but also by otherwise learned men to be produced from dew or in a manner wholly inexplicable.

Leeuwenhoek is in no doubt whatever as to all these things being prodigious absurdities bred of á priori zoology and Aristotle. "For my part," he says, "I hold it equally impossible for a small shell-fish to be produced without generation as for a whale to have its origin in the mud." He had risen to the principle in a way that a great many people at the present day have not risen, that size has nothing at all to do with the essence of phenomena; the antecedent of a living thing is a living thing and not non-living matter or dead matter however putrid it may be.

He demonstrated to his daughter and to his engraver the embryo of Unio, the fresh-water mussel. They "watched it for three whole hours."

He was particularly delighted with his discovery of the embryo eels in the body of the female, since he had been challenged to show how eels were bred.

These superstitions died very hard. Well on into the 18th century we have Father Needham (1748), and later Spallanzani (1776), bringing fresh proofs against Abiogenesis, and introducing sterilization; and Caignard-Latour (1837), Schwann, and Helmholtz worked at the same problems. But the coffin of this dead heresy was rapidly approaching completion; Leeuwenhoek had found the wood, the others had put

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it together, while it was reserved for Pasteur and Tyndall in our own day to hammer in with triumphant blows the last two nails.

In the case of "weevils" of granaries, he showed that they were not produced by wheat, but were grubs from insects' eggs. He suggested that the granaries should from time to time be fumigated with sulphur to destroy the insects before they laid their eggs. This is quite in the modern spirit, he wished to use some sort of *chemical* to destroy life.

In other words, he is not the mere histologist magnifying "the difficulty, looking it full in the face and passing on," but he is a physiologist as well, trying to solve it.

He knew that the atmospheric air was necessary to maintain life, even the life of parasites on trees. He writes in 1700 of a free circulation of air as necessary for insects he had imprisoned in a glass tube for observation. In other words, he understood ventilation as few in his day, except Stephen Hales, did, and had people understood it earlier there would have been less of gaol-fever and typhus fever everywhere, and poisoning of people to death on board ship.

He speculated on the use of the lacteals, of the "slime of the guts," and made an experiment to determine the amount of aqueous vapour excreted daily from the skin. He weighed a glass vessel dry, inserting his hand into it and, closing up the orifice by a handkerchief packed round his wrist, he found moisture condensed on the inside of it. On weighing the vessel at once before the moisture evaporated he obtained a distinct increase of weight, and by knowing the area of skin that had produced this, he arrived at the amount of sweat excreted per unit of surface-area. He then estimated the total area of the skin and found that the whole body per 24 hours must eliminate about 28 fluid ounces, which is not very far from the truth.

Leeuwenhoek was evidently possessed of sound commonsense. He could not bring himself to believe that the blood underwent any kind of a "fermentation" analogous to that of beer or wine as was at the time almost universally taught in the medical schools. He very sensibly said that he had never been able to see any bubbles of gas in the blood-vessels such as ought to have been there had the blood been the seat of fermentation as he knew it. However necessary this fermentation of blood was to the theoretical physiology of his day, that Leeuwenhoek could find no evidence of it was a serious objection seeing that he was one of the very few who was in the habit of looking at the living blood. Thus, although not a physician, and not even a professional man of science, he was a good deal ahead of the physiology of his day in respect of some of its most important principles.

As a lover of pure science, as a most industrious worker with the microscope, and, for his day, a prescient physiologist Leeuwenhoek is interesting to all biologists, but by histologists and bacteriologists his name will ever be regarded with that reverence which a bright example in science must always inspire. The man who first saw and described a micro-organism must be interesting to us to-day, seeing of what importance the microscope and the science of bacteriology have become in modern life with their relations to applied medicine, pathology, surgery, public health, the arts, and commerce. The seed of this gigantic tree, with its roots in all lands and its flowers culled under every clime, was shown by the hand of a solitary worker without reward in a quiet little town on one of the canals of the great plain of Holland.

Photography: Pure and Applied.

By CHAPMAN JONES, F.I.C., F.C.S., &c.

Radiations from Metals.

Some two or three years ago N. Piltschikow published his results obtained with "Moser rays," that is, "rays" emitted from metallic and some other surfaces, which increase as the moisture present increases, which are deflected by a stream of air, are unaffected by electric and magnetic fields, and practically cease to exist in a vacuum. The "rays" are not vaporous, and are able to pass through thin layers of paper, celluloid, gelatine, or aluminium. They are of three sorts (1) those that render silver bromide developable; (2) those that render developable silver bromide undevelopable; (3) those that have no effect on silver bromide. "Rays" of the first kind are emitted by manganese, aluminium, zinc, cadmium, tellurium, selenium, iron, cobalt, nickel, silicon, boron, lead, tin, zirconium, platinum, palladium, and colloidal silver; of the second kind by osmium and tantalum; and of the third kind by copper and brass; while gold, iridium, rhodium, ruthenium, molybdenum, and mercury emit practically no "rays."

B. L. Vanzetti (*Chem. Soc. Abstracts*, 1908, ii., 915), in investigating the nature of certain catalytic reactions, finds that certain metals when placed at from .5 to 1 mm. from a gelatino-bromide plate produce results that are different from those given by light and by certain metals as investigated by Dr. Russell, as the action takes place chiefly at the surface of the film and penetrates the gelatine very slowly. The effects are specially marked in moist air; they disappear if the air is dried with phosphoric oxide, and are greatly diminished in a vacuum. The metals may be arranged in a series in which the power of converting silver bromide into the developable condition diminishes in the order of progress from the first, and the power to render developable silver bromide undevelopable increased towards the last—thus: Cadmium, zinc, aluminium, lead, iron . . . copper, tin, silver, palladium, iridium, nickel, gold, platinum.

It must be admitted that whether or not the effects described by these two investigators differ at all from those examined by Dr. Russell, they bear a very marked similarity to them in many ways. The important fact for the outsider, beyond the primary fact that such actions as these have been observed by so many that their existence cannot be doubted, is that different investigators get different results, and, of course, draw different conclusions. While Piltschikow finds that platinum converts silver bromide into the developable condition, Vanzetti finds that it has quite the opposite effect. The latter finds that gold renders developable silver bromide undevelopable; while the former finds that it has no effect on it at all, and so on. On previous occasions I have pointed out how contradictory results have been recorded by different workers with metals as well as with other substances. One is forced to the conclusion that much of the work that has been done in this connection has been carried out by the various investigators under different and, perhaps, imperfectly recorded conditions, and it is doubtless the unobserved variations in the conditions that are the causes of such apparently contradictory results.

"Ensyna" Printing Paper. This development paper, recently introduced by Messrs. Houghton, is of considerable interest both practically and theoretically, for it has properties distinct from any silver paper hitherto put upon the market. The sensitive substance contained in the film is not a halogen salt of silver, but appears to be chiefly or entirely silver phosphate, a salt which was examined some fifty or sixty years ago, when almost every salt of silver then known was subjected to experiment, but without sufficiently encouraging result to lead to a continuance of its use. The new paper, however, gives remarkable results. With a certain minimum exposure, which is comparable to that necessary for ordinary slow development papers, and suitable development, a purplish image is obtained quite similar in appearance to an ordinary toned silver print on a printing out paper. An increase in the exposure will give an image tending more and more towards a warmer colour, until by a suitable increase a reddish brown image results. Thus any colour may be obtained between these two extremes, without any toning operation, by merely adjusting the length of the exposure. The extent of development regulates the depth of the image, but does not alter its colour. The development in this case is different from the development of plates and bromide prints. The image is formed by the deposition of silver from the solution that contains the developer upon the "latent" image formed by the exposure. The special developer necessary is supplied with the paper. It is claimed that a print may be produced, from first to last, in a very few minutes; for development is rapid, the print may be passed direct from the developer to the fixing bath, while half a minute in this followed by a two-minutes rinsing or washing is stated to be sufficient. As silver phosphate is very soluble in the thiosulphate, the short fixing period may be sufficient, but the short time of washing cannot result in the removal of the thiosulphate so completely as is customary.

Washing. Since the introduction of Autochrome plates there have been other cases than that just referred to where a very short washing has been claimed to be all that is necessary. But the Autochrome plate has a very thin film on an impervious support, and is quite different from an ordinary gelatine film or any printing paper. In the latter case it is not only the film, but the paper also that absorbs the fixing bath solution, which, of course, contains silver, and unless as much as possible is washed away, a considerable risk is incurred. Certainly a few prints, merely rinsed, may last a considerable time, but what is wanted in all silver processes is the exercise of the greatest care to render the life of the photograph as long as possible, and unless the washing away of the fixing solution is as complete as possible it cannot be claimed that this care has been taken.

Rudolf Duhrkoop's Portraits. There is now open at the premises of the Royal Photographic Society, 66, Russell Square, an exhibition of about ninety portrait subjects by Rudolf Dührkoop, of Berlin and Hamburg, which are of considerable interest, as Mr. Dührkoop has been striving since about twenty years ago to demonstrate in his professional work how false and unnecessary are the conventional studio methods. Mr. Dührkoop is now recognised as one of the foremost of Continental portrait photographers. The exhibition will remain open until the end of this month and admission, from 11 a.m. to 5 p.m. daily, is on presentation of visiting card.

Folk-tale and Flower-lore.

By W. M. E. FOWLER.

WHO would be without a garden? It is difficult to surpass the beauty of roses and lilies, or the more gorgeous colouring of ribbon borders; while the fragrance of mignonette, and the trailing glory of nasturtiums and clematis make a substantial part of our summer days. Old introductions as many of these cultivated flowers are, their various attractions have not won for them the love and sentiment which has gathered around their more lowly but indigenous relations.

Our wild flowers, many of them inconspicuous, dull blossomed weeds, are all regarded with interest, and especially so by country people and children. Year after year, as season follows season, little girls remember the spots where their favourites are known to flower, and warm handfuls of drooping violets, or untidy bunches of long-stalked "moonpennies," will be diligently gathered for teacher and mother. The more material boys can tell where the best hazels and fattest pig-nuts grow, or point out the popular horse-chestnut tree, under whose branches may be collected the much prized "conquerors."

It is surely this natural love and interest in flowers that was the origin of the many quaint sayings in connection with them; sayings, which through countless generations, have been perpetuated by constant repetition. "You can't gather rabbit food without finding nettles" is an apt Lincolnshire proverb, and in the West Riding of Yorkshire, where bunches of dried quaking-grass are to be seen on every cottage mantelpiece, the goodwife will account for their presence by reminding you of the old saw, "A trembling-jock in the house, and you won't have a mouse."

Bright-coloured plants are generally the subjects of pretty stories, as the dull-tinted flowers are of the ugly ones. Should an old woman gather silverweed, she will have joy and riches; whereas if a child picks the dark selfheal or "black-man's-flower," the devil will fetch him away in the night.

In Hampshire we are told that the spots on the leaves of "Virgin Mary" (*Pulmonaria officinalis*) were caused by the Holy Mother's tears falling upon them as they grew at the foot of the cross. Also that from excessive weeping her blue eyes became red, in consequence of which this, her plant, now bears the two-coloured flowers. In the same county, country people repeat the story of Abel's death, of the sacrifices and murder in the open, and of the drops of blood, which, falling on the then pure white daisies, dyed some of them with a ruddy stain, marks which they carry to this day.

From the village children we learn the lesson of the speedwell. They believe that this is the birds' special flower, that the little songsters love it and watch over it; and the hedge-sparrow, known as Dicky Dunkin, builds its nest and lays its blue eggs over the spot where this, the bluest of our wild flowers, is found. Should a child gather the quickly falling "birds'-eyes," the dunkins will fly home ahead of him, and, in revenge, pick at his mother's heart, so that when he reaches the house it will be to find her cross, worried, and "put out" with him and his companions. For this reason the plant is sometimes known as "Pick-your-mother's-heart-out."

The hedge-row favourites have acquired many

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names, varying in different localities, but all more or less characteristic of the plants to which they are applied. North country villagers could not tell what figwort is, but talk to them of "fiddles," and many will remember the time when, gathering the tall square stalks, they stripped them of their leaves and dingy brown flowers, and, rubbing them together, produced a squeaking noise sufficiently suggestive to make an ill-smelling and inconspicuous weed worthy of a second name.

While some names are descriptive of general appearance, others suggest virtues, or doubtful qualities, Thus, "trembling-jock," or "ladyshake," for the *Briza media* of our meadows; "dead-man's-hands," for the palmate-rooted *Orchis mascula*; "shirt-buttons," for the round, white-blossomed *Stellaria holostea*; "parson-in-the-pulpit," or "bloody-finger," for *Arum maculatum*; and "devils'-candles" for the white night-flowering *Lychnis vespertina*; while the longest English plant name, "meet-her-e'-the-entry-kiss-her-e'-the-buttery," has been given to the wild tricolour pansy. Some seemingly inappropriate titles are corruptions of what in past times were suitable enough. Herb Bennett, or Bonnet, was once the Herb Benedict or Blessed herb; a plant supposed to possess great medicinal virtues, as well as much power over evil spirits. Bedlam sage should be Bethlehem sage, doubtless connected with the sacred birth-place, on account of its supposed invaluable properties.

The boys and girls, playing in the fields, distinguish the daisies tipped with red as "blushing young girls," from the white ones, which are "grey-haired old women"; and, holding the yellow buttercups under the chins of their companions, judge by the reflection of colour how fond each is of butter. The profound gravity with which these small people open the seed-vessels of the shepherd's-purse (*Capsella Bursa-pastoris*) is very entertaining, and from their point of view the situation is truly worthy of interest, for should the enclosed seeds be ripe and yellow, their possessors are about to become rich; whereas green unripe contents of the "purse" denote poor monetary prospects.

On their way home from school, Fenn children search for the hooded spikes of the "lords-and-ladies." These are left for the night, soaking in a bucket of water, to be eagerly inspected on the following morning, as in the interval they *may* have turned into "something else," cats, hens, or even cattle.

No one would wish to disparage the wonderful results of cultivation, but while admiring the beauty of our gardens and hot-houses it is well to remember the wayside weeds and country flowers, and realise that with their greater antiquity springs up a vast amount of love; while unnumbered folk-tales and sayings gather round their changing blossoms.

Solar Disturbances During December, 1908.

DURING December the increased activity noted in the previous month was maintained. The meteorological conditions, however, made regular observing somewhat difficult. The longitude of the central meridian at noon on December 1st was 258° 2′.

No. 176 was shown on the chart for November, but remained visible until December 9th.

No. 177.—A solitary pore only seen on 6th.

No. 178.—On 6th a considerable spot which had a diameter of 32,000 miles. On 8th there were pores north and east, the remains showing on 9th, the spot solitary after until 14th.

No. 179.—A pore on 6th, but by 11th a group of four. Not seen 12th, but again noted on 14th.

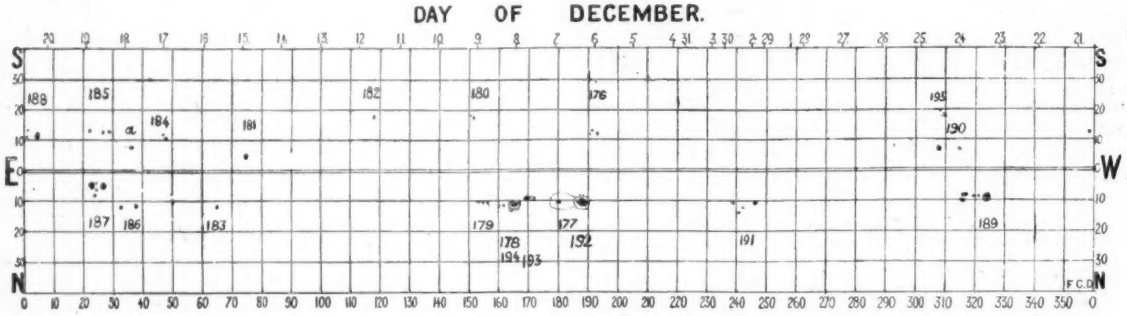
No. 180.—Two tiny pores only seen on 8th.

No. 181.—A spotlet seen just on disc 9th, and gradually dwindled until 13th.

No. 182.—A large pore seen 10th, but not after.

No. 183.—Just round the limb on 10th was a small spotlet, noted as not black on 15th when last seen.

No. 184.—Pores only seen 17-18th, but area was bright with faculæ on 22nd.



No. 185.—A bent line of three pores 17th and 18th, and one showed again on 22nd.

No. 185*a*.—A pore north-west of 185 on 20th only.

No. 186.—Two pores 47,000 miles apart seen only on 18th.

No. 187.—A lozenge-shaped area marked east and west by larger spotlets, and north and south by pores. On 20th there were two spots each 16,000 miles in diameter. By 22nd a triangle 3° by 4° marked out by a spotlet and three or four pores, but not seen after.

No. 188.—Three pores on 20th, four on 22nd, the leader being largest, the latter was still visible until 26th accompanied by faculæ.

No. 189.—In the interval between 22nd and 25th an active group broke out 72,000 miles in length, the leader being 16,000 miles in diameter. Its maximum was reached on 27th, had much decreased 28th, and seems to have disappeared before 30th.

No. 190.—A spotlet and pore on 22nd, a small group 52,000 miles in length on 25th, and two pores only on 28th.

No. 191.—A little spotlet, with pores following it, to a maximum length of 55,000 miles, seen 27th until January 2nd.

No. 192.—A fine spot 27,000 miles in diameter with a train of pores mostly behind it. As it crossed the disc its diameter somewhat decreased, and the pores

showed constant change. December 30th to January 9th.

No. 193.—A spot, with pores preceding it, only seen 30th.

No. 194.—A return of No. 178, now, however, only 22,000 miles in diameter, from December 30th to January 9th. Very little trace of disturbance seen around, except a pore north noted on January 6th.

No. 195.—A group of about four pores in a faculic patch seen only on December 30th.

The chart is constructed from the combined observations of Messrs. J. McHarg, A. A. Buss, A. Mee, and F. C. Dennett.

CORRESPONDENCE.

The Making of Handwriting.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—I am interested in a reprint in a recent issue of *The Literary Digest* (New York) of a portion of C. Ainsworth Mitchell's article which originally appeared in your magazine, on handwriting as affected by hypnotism and as an inheritance.

Mr. Mitchell does not make very strong claims in either of these directions, but such claims as he does make, are, I think, disproved by the experience of others—and by the very illustrations reprinted from Mr. Mitchell's article.

Writing is partly physical and partly mental. Through study and environment we acquire a mental conception of the style of penmanship we desire. Through practice we apply our mental concept to paper. Of course, environment, occupation, and many conditions tend to modify our writing ideals. You would not expect the blacksmith to write as well as the insurance policy engrossing clerk even if both had the same parents and attended the same school, and had the same training in writing. The blacksmith perhaps did not like to write, and his handwriting retrograded, while the insurance clerk, discovering that his advancement depended largely on the excellence of his penmanship, studied and practised in his efforts to improve it.

These conditions would operate to produce two handwritings at the opposite poles so far as quality was concerned—and they would be just as far apart in characteristics.

There is no fallacy regarding characteristic handwriting more widespread and insistent than that handwriting is largely inherited. I do not believe it is inherited even in a small degree that would serve to connect the writing of the children with that of the parents, even by an expert.

The majority of children do not write like their parents. The minority who do follow the style of penmanship of their fathers and mothers, copy this just as they copy mannerisms of gesture, voice, etc. To the boy who thinks that his father is the most wonderful man in the world, it is most natural that everything the father does will be a model for the son—including handwriting. Then, again, he will see his father's writing probably oftener than the writing of other people. And the same thing applies to mothers and daughters.

The style of penmanship and methods of teaching in schools have much more influence on handwriting than heredity. Pupils from five to fifteen years under the same teachers and environments, practising from the same copy-books, and being taught the same methods will write so much alike that it will defy the expert to separate the writing of one from another.

Some years ago I asked the Packard Business School of New York to give to one class of forty young men and women, sixteen to twenty years of age, a copy: "This is a specimen of my writing," without any special instruction and without informing them that the specimens were wanted for any special purpose. The copy was given in the usual way. The students had been under the same writing teachers for six months and were being trained for business. So nearly alike were the different specimens that when they appeared in connection with my article in the *Saturday Evening Post*, of Philadelphia, a lawyer wrote to the editor and denounced them as an attempt to deceive the public by publishing specimens all written by the same person. These specimens are shown herewith.

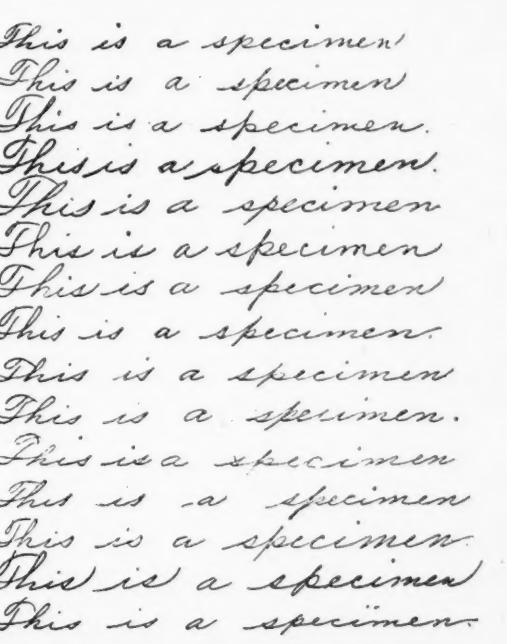
The only way to test heredity in handwriting would be in cases where children were separated in infancy from their parents and never saw any of the parents' writing.

I have no doubt that English or German born children, educated in the United States, under the conditions mentioned would write in the American style.

As to the influence of hypnotic suggestion on handwriting, I have made experiments and have arrived at the opposite conclusion from Messrs. Mitchell, Lombroso, and Richet. The Napoleon and Garibaldi illustrations on page 837 of the *Literary Digest* of December 5, in my opinion, refute rather than confirm the contention of these investigators.

In my experiments I found that the subject wrote the same hand whether in a normal or hypnotic state—and made the same mistake in spelling.

Putting the pen in the hand of an illiterate person and commanding him to write while under hypnotic influence would produce pen marks, but nothing legible. Or if a subject could write, and were told to produce the signature of some person of whom he had no knowledge, there can be no doubt that the resulting writing would not be characteristic of the unknown person.



Each of these lines was written by a different person, showing influence of training on handwriting.

Nothing that man does and leaves on record is so characteristic and individual as his handwriting. But in the school or formative period the handwriting of a young man is much like that of other young men of similar education and environment. And young women copy the styles of other young women in handwriting as they copy styles in dress.

As the value of identifying the individual and connecting him with his acts by means of his handwriting becomes known, it is brought more and more into use in the courts in the United States and Europe.

But connecting this very practical use of handwriting identification with graphology (character reading), or such articles as Mr. Mitchell's on heredity and hypnotism, has

a tendency to hurt the influence of the handwriting expert who disclaims all ability in the direction of graphology, heredity, and hypnotism.

Yours, etc.,

New York, U.S.A. WILLIAM J. KINSLEY.

[Evidently my critic has not read the whole of my article, since much of his letter merely illustrates what I wrote. I attempted to draw a sharp distinction between normal writing, in which no attention has been paid to the form of the letters, and abnormal artificial writing, which is often the result of conscious imitation. "Copy-book" writing is no more the real writing of an individual than printed capitals would be, even though, like the engrossing clerk, he copies his model so frequently that he ceases to be conscious that he is copying it.

It is admitted that resemblances between the handwriting of parents and children do exist, but whereas I claim that this is due to inherited traits finding expression in the writing, my critic contends that it is the result of conscious or unconscious imitation due to veneration for one's father or mother. At the same time he draws, as I did in my article, a comparison between handwriting and tricks of gesture, voice, gait, etc. Now, to apply his line of argument, surely it is carrying veneration for one's ancestor to an absurd pitch to try to copy his frequently objectionable mannerisms.

Apart from this, instances are known to me where a child has been left an orphan at an early age, and has grown up unacquainted with his father's writing, and yet has reproduced many of the characteristics of that writing. Is not heredity a more reasonable explanation in such a case than any far-fetched suggestion of imitation? Even when what I must describe as the vicious style of a writing school has been acquired, the handwriting may revert to its normal state, and will then tend to show indications of inherited traits.

With regard to the question of hypnotism, are not positive results obtained by such scientific workers as Professor Lombroso more conclusive than negative results obtained by others? The different signatures of Professor Lombroso's hypnotised student are strangely dissimilar and can hardly be explained away.

My critic fears lest any recognition of the result of external influences upon handwriting should discredit the value of the opinion of the handwriting expert. Many rash statements have been made by experts in the witness box, but I doubt whether even that gentleman who claimed infallibility for himself and his son (though, by the way, they once appeared on opposite sides)—I doubt whether even he would have been so rash as to assert that all the writings done by Professor Lombroso's student were the work of one and the same individual.—C AINSWORTH MITCHELL.]

Denehole s.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—It should be borne in mind in investigations relating to the age of these interesting workings that in places where tools have been found associated with chalk excavations of clearly prehistoric origin, as, for example, at Grime's graves and Cissbury Hill, the picks found have been fashioned from antlers of the red deer. Mr. E. Lovett, in his excellent account of the flint industry at Brandon, published in the *Illustrated Archæologist* (June, 1893), figures one of these found at Grime's graves, and in his possession, and alongside this he has sketched a modern iron pick for comparison, the curve and position of the iron pick-head corresponding to that of the brow antler of the stag-horn; the iron implement, however, is not so sharply pointed, and is somewhat broader. It may interest some of your readers to know that a few months ago a section of a denehole shaft, about 70 feet in height, was to be seen, and I believe is still exposed, at Galley Hill, Kent. The chalk cliff had been cut away perpendicularly and the steps cut in the shaft were clearly to be seen from top to bottom.

Yours, etc.,

London, S.E. THOS. HENRY POWELL.

Physical Constitution of the Moon.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—I have read with much interest the letter of Mr. H. L. Meadows on the physical constitution of the moon, in your last number. It occurred to me, after reading his letter, that the main features of the moon might indeed have been formed by the impact of matter from without it, and not by volcanic action from within it, but that, more probably, *they were not formed by the impact of fragments of the earth, but by meteoric fragments.*

It is almost certain (if we accept the latest theory of the cosmogony) that when the moon parted from the earth both bodies were in a *nebulous* state, so that, at that time, the so-called craters, etc., could not have been formed. But it is quite possible that they were formed by meteor fragments, which would have a very great effect on the moon, because it has no protecting atmosphere.

We have some evidence of such a thing happening on the earth in the meteor crater of Canyon Diabolo, which is probably formed by a meteoric fragment. This crater is three-quarters of a mile across ("KNOWLEDGE," July, 1908). I should be very pleased if I could have a little criticism on this subject from anyone.

Yours, etc.,

London, N.W. J. E. MAXWELL.

Euclid's Definitions.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—In my letter dealing with the question of Euclid's Definitions I wished to avoid as far as possible the subject of the teaching of geometry, so as not to obscure the main point at issue. However, it seems that something might be added on this matter. In my above-mentioned letter I came to the conclusion that there were two courses possible—(1) Make the best bargain possible with logic, and teach Euclid or his modern successors. (2) Recognise the difficulties connected with a logical study of theoretical geometry and defer the subject to a later date, employing the time meanwhile with practical geometry instead. Personally, I have no hesitation in choosing the latter of these alternatives.

It is a self-evident maxim of educational method that we should proceed from the concrete to the abstract, and it is certainly surprising that this maxim should have been ignored in the teaching of geometry until quite recently. The effects of this neglect have been evident. Euclid has been one of the best-hated of school subjects because the least understood, whereas practical geometry and mensuration are always appreciated by elementary students because they deal with concrete facts which have significance for their minds.

I think myself that theoretical geometry should only be studied after a course of practical work, and this I take to be Mr. J. F. Hammond's view also. With regard to the letter written over the pseudonym of "Dabbler in Geometry," since it is evident that the authors of anonymous criticisms do not themselves consider their remarks worthy of signing, it is unnecessary to deal with the same.

Yours, etc.,

The Polytechnic, Regent Street, W. H. STANLEY REDGROVE.

ASTRONOMY.

By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.S., F.R.A.S.

Search Chart for Halley's Comet.—Owing to the somewhat uncertain character of the perturbation constants it is impossible to obtain any certain ephemeris for this comet, but the calculations of Cowell and Crommelin have given very convincing accord by two different methods of work, and for searching purposes intending observers cannot do better than follow their positions. At the last meeting of the Royal Astronomical Society they announced that

recent work had suggested the shifting of the computed time of perihelion from April 8 to April 13, 1909. The following ephemeris, however, is based on the earlier value, no other being yet available :—

	R.A.			Decl.	
1909	H.	M.	S.		
Jan. 14·8 ..	5	38	52	+11°	49N
March 2·6 ..	5	7	48	13	10
April 15 0 ..	5	10	0	14	52
May 25·0 ..	5	21	4	16	15
June 30·7 ..	5	41	48	17	6
Aug. 3·2 ..	6	1	20	17	29
Sept. 2·7 ..	6	14	52	17	31
Sept. 30·5 ..	6	16	36	17	20
Oct. 25·5 ..	5	28	24	17	21
Nov. 17·0 ..	5	8	8	17	4
Dec. 7·2 ..	3	42	28	15	16
Dec. 25·1 ..	2	16	4	+11	46

From the accompanying chart, plotted from the above ephemeris, it will be seen that the comet is at present passing almost due westward through the upper region of the constellation of Orion. Near the beginning of March it turns north, and then north-east through Taurus and Orion, until September, when it again turns westward and passes through Taurus and Aries. As it is most probable that the comet will come within the reach of photographic methods before it is seen visually, these positions may be sufficiently accurate for adjusting the axis of the camera to the region, and the field covered by the

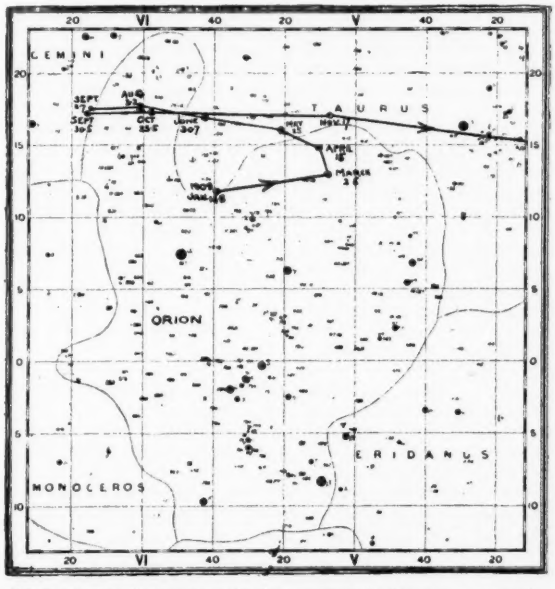


Chart of computed path of Halley's comet during 1909. (Cowell and Crommelin.)

lens will extend for some considerable distance away in all directions.—(*Royal Astronomical Society Monthly Notices*, Vol. 78, p. 393, March, 1908.)

Mr. W. F. Denning, in discussing the mean period from former apparitions, concludes that at the middle of January, 1909, the comet will be 445 millions of miles from the earth, and if it is not detected before the end of the month observers will have to await its visual apparition until the next autumn, as its distance will be increasing in February. —(*Observatory*, Vol. 32, p. 63, January, 1909.)

Search for an Ultra-Neptunian Planet.—Professor W. H. Pickering finds evidence of the existence of a planet lying beyond Neptune, which in 1909 will be located approximately in R.A. 7^h. 47^m. Decl. + 21°. This is the result of an investigation, which will be published in full in the Harvard Annals, an abstract of which was read at the November session of the American Academy of Arts and Sciences. Photographs of the region have already been taken with the 24-inch Bruce telescope at Arequipa, and astronomers in general are invited to participate in the search, and a systematic study of this portion of the ecliptic is regarded as desirable.—(*Harvard College Observatory Circular*, No. 144.)

Total Eclipse of the Sun, April 28, 1911.—In view of the somewhat favourable conditions for the total solar eclipse occurring on April 28, 1911, Dr. Downing gives the following details of the local particulars. The most suitable site appears to be Vavau Island, one of the Tonga group, which is situated nearly on the central line of totality, and is otherwise a most convenient observing station. The island is nearly 9½ miles long from east to west, with an extreme breadth from north to south of 6¾ miles; it is covered with thick bush and cocoanut trees, and has numerous tracts under cultivation. Neiafu, on the south-west coast, one mile east of Talau Hill, is the port of call for mail steamers, communicating with Sydney every four weeks. The Governor resides there, and various trading firms have their headquarters in the town. There is a good wharf, accommodating vessels up to 18 feet draft.

NEIAFU. Long. = 173° 59′ W; Lat. = 18° 39′ S.

	Local Mean Time.				Angle from— North Point.	Vertex.
	D.	H.	M.	S.		
First Contact ..	April 27	20	26	47	230°	350
Total Eclipse ..	„ 27	21	37	1.7	36°	169
	„ 27	21	40	38.5	242°	15
Last Contact ..	„ 27	22	58	48	49°	203

Duration of totality .. .. = 3^m 36^s.8
Sun's altitude at totality .. = 43°
Sun's azimuth from North .. = 49°

—(*Royal Astronomical Society Monthly Notices*, Vol. 69, p. 30, November, 1908.)

Sixth Type of Stellar Spectra.—During the progress of the work of stellar classification of the Henry Draper memorial, numerous objects have been detected which do not completely agree with any one of the five types of stars which have hitherto served for cataloguing purposes, and have been classed as "peculiar." Their number is now sufficiently great to cause inconvenience by the necessary cross-references, and Professor Pickering suggests the adoption of a distinctive class denomination for these objects. This would include doubtful fourth type stars, whose spectra contain radiations of much shorter wave-length than those of normal fourth type; stars similar to fifth type, but having one or more dark bands, and resembling fifth type stars reversed with bright bands on a continuous spectrum. A list of 51 of such objects is given, and a reproduction showing several of their spectra, with comparisons of types I., IV. and V. It is proposed to name the new group Type VI., class R.—(*Harvard College Observatory Circular*, No. 145.)

White Spots on Mars.—Professor Lowell devotes a special circular to the description of a series of distinctive white spots, which have been observed in the arctic and sub-arctic zones of Mars. These show themselves at certain seasons of the Martian year quite permanent in place and persistent in character. They are not absolutely restricted to any one zone, but appear to be remarkably attached to certain localities, recurring year after year in the same places. But for the practical certainty that there are no mountains on Mars, these white spots might be regarded as snow-fields or glaciers collected on high uplands. The circumpolar series of spots have been observed at Flagstaff during four apparitions, 1901, 1903, 1905, and 1907, and a list of these with their positions is given; the largest of them was recorded by Schiaparelli in 1884, and again in 1886 and 1888.—(*Lowell Observatory Bulletin*, No. 34.)

XUM

BOTANY.

By G. MASSEE.

Cascara Sagrada.—It is perhaps not generally known that this drug is furnished by the bark of two trees belonging to the Buckthorn family, *Rhamnus purshiana, D.C.*, and *R. californica*, Eschsch., natives of Western North America. According to the *Kew Bulletin*, specimens of both species have been in cultivation in the Royal Botanic Gardens, Kew, for many years. Since the introduction of the drug into medicine, some thirty years ago, there has been a rapid destruction of the wild source of supply, and judging from the way in which *R. purshiana* has flourished at Kew, it is considered probable that this tree may be grown on the western coasts of the British Islands.

In order to ascertain whether the bark of an English-grown tree would furnish the drug in the same percentage and of equal quality as that of native samples, one of the Kew trees was cut down for the purposes of analysis. The report submitted by Messrs. Burroughs, Wellcome and Co. states that the extract was indistinguishable in its action from that made from American bark, and a physician reported it to be equal to the average of tabloid products from bark grown in America.

Those interested in this subject from a commercial standpoint should consult the *Kew Bulletin*, No. 10, 1908, for cultural and other details.

The Lace-Bark Tree.—An interesting account is given by Dr. G. V. Nash, in *Journ. N.Y. Bot. Gard.*, of the lace-bark tree (*Lugetta lintearia*), of Jamaica. Its first introduction into cultivation was at the Royal Botanic Gardens, Kew, where it was received in 1793. It is as yet rare in cultivation, and has only once been recorded as flowering in the United States. It is interesting on account of its restricted distribution, being principally confined to the central and western parts of Jamaica. It has, however, also been said to occur in Haiti. The tree attains a height of twenty to thirty feet, and its ovate, light green, shining leaves are very attractive. The flowers are fleshy, creamy-white, and borne in long, slender, spike-like racemes. The special interest of the tree, however, lies in the peculiar structure of its inner bark, which is composed of fibres arranged in several distinct layers, each of which can be stretched into a loose lace-like fabric, hence the popular name "lace-bark tree," also the specific name of "lintearia," of, or belonging to, linen. In former times, and even at the present day to a less extent, this bark is used for making capes, ruffs, bonnets, and even entire lace suits. During the days of slavery branches of this tree were converted into whips, used in beating the negro slaves. A certain amount of a branch was used as the stock, and from the remainder of the branch the wood was removed, and the lace-bark was plaited to form the lash. The bark was extensively used by the Spaniards in the manufacture of rope, and the Indians, from time immemorial, have used the bark for a great variety of purposes.

Dissolution of Hemicellulose by Fungi.—An account of a series of experiments is given by Schellenberg, in *Flora*, bearing on the action of certain fungi on the hemicelluloses of plants. *Molinia caerulea, Lupinus hirsutus, Phœnix dactylifera, Impatiens balsamina, Cyclamen europæum*, and *Ruscus aculeatus*, furnished the hemicelluloses. A large number of fungi were experimented with, and it was found that they were highly specialised in their action, which differed much from the influence exerted on true cellulose; such specialised action necessitated the assumption of at least four different enzymes. Similar results were obtained on both living and dead material.

These experiments prove that fungi possess the power of removing hemicelluloses from true cellulose in tissues that are not lignefied.

This discovery suggests that fungi assist in decomposing plant tissues present in the soil, to a far greater extent than has hitherto been suspected.

The Perception of Light by Plants.—It is well known that Haberlandt favours the idea that certain lenticular epidermal cells, ocelli, etc., of the leaves of plants, possess the power of discriminating between relative degrees of light intensity. Dr. G. Albrecht gives the result of an investigation bearing on Haberlandt's views in *Ber. d. deutsch. Bot. Ges.* He examined a considerable number of endemic North German plants, and finds that the structures in question are quite rare, and that when present are nearly always as numerous on the under as on the upper surface of the leaf, although all known movements for placing the leaf in the most favourable position with regard to light, have reference to the illumination of the upper surface alone.

Emergence of Lateral Roots.—Up to the present time Van Tieghem's view that young lateral roots emerge by the disintegration of the tissue of the parent root by means of an enzyme, has been almost universally accepted. Mr. R. H. Pond, however, has recently paid attention to this subject, and his summary, as given in the *Botanical Gazette*, is as follows: "The lateral roots of *Vicia faba* and *Lupinus albus* push out from the central cylinder through the cortex, *mechanically*, and do not have a digestive action upon the surrounding tissue."

It may be stated that the two plants named above were also used by Van Tieghem in his investigations.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (Oxon), F.I.C.

Artificial Sapphires.—Crystalline alumina occurs in nature in several forms. Of these, corundum is a substance that almost rivals the diamond in hardness, while the ruby and the sapphire also consist of nearly pure crystalline alumina coloured by traces of metallic impurities. Attempts have frequently been made to manufacture sapphires, and small blue crystals are said to have been obtained by allowing the vapour of aluminium fluoride to act upon boron anhydride at a high temperature, though hitherto it has not been found possible to obtain stones of larger size. The difficulties in the way of making sapphires have now been overcome by M. L. Paris, who has published the results of his experiments in a recent number of the *Comptes Rendus*. When alumina is fused in the oxyhydrogen flame it becomes transparent, yielding a crystalline product to which a red colour is readily imparted by the addition of a little chromic oxide. The mass is not coloured blue, however, by oxides of cobalt and iron, since these remain on the surface as a fused layer, while the interior remains colourless. But if a trace of lime be present in the alumina diffusion of the oxides occurs and the whole fused mass may be coloured blue by the addition of various metallic oxides, especially that of cobalt. The artificial sapphires thus obtained consist of amorphous silica, with a crystalline surface layer, and, as regards their physical characteristics, stand in the same relationship to the natural stones, as does fused silica to quartz. They are exceedingly hard, and of a rich blue colour, and are not easily distinguishable, even by experts, from natural sapphires.

Protection of Copper from Corrosion.—Numerous are the remedies that have been tried to prevent the corrosive action of sea-water upon copper or brass, for tar, paint, and the like do not afford protection for any length of time. In experiments to devise a remedy, it was found by Herr Uthemann, of the Engineering Council of the German Navy, that an electrolytic coating of iron upon the copper was also unavailing, the sea-water soon dissolving the whole of the deposit. In further experiments, however, an ingenious method of coating the copper with a deposit of iron oxide proved successful. The copper or brass was wrapped round with iron wire before being placed in the water. The sea-water immediately acted upon the iron, gradually oxidising it, and the resulting iron oxide soon began to adhere to the surface of the copper. At first the deposit formed between the wrappings, but eventually it also extended beneath the wires themselves. The protective coating thus produced was not removed by a strong

current of water, and still prevented the sea-water from attacking the copper, even after the iron wire had been taken off.

Chemical Antidotes to Fatigue.—Under certain circumstances, the decomposition-products formed from nitrogenous substances in the body may be produced in such quantity and so insufficiently eliminated from the system, as to cause auto-infection. An interesting illustration of this is afforded by the experiments of Professor Mosso, of Turin, who, in 1887, found that the illness caused by over-fatigue was due to the absorption of certain compounds into the blood, and that these substances when injected into other animals produced the same symptoms. The presence of such toxines is probably the explanation of the illness sometimes caused by eating the flesh of over-hunted game, or of over-driven cattle. Liebig, in his "Letters on Chemistry," mentions a case in which the flesh of a roebuck which had struggled violently after being caught in a snare, gave rise to symptoms of poisoning. Similar cases are recorded by Gautier, including one in which pigs were fatally poisoned through being fed upon the flesh of a horse that had died during its struggles when being broken in.

At first these poisonous products of fatigue were regarded as animal alkaloids similar to the poisonous alkaloids, such as strychnine and brucine, produced by plants, but it was subsequently demonstrated by Dr. Roger that any crystalline products were only moderately poisonous, and that the true toxic products of the muscle were of an albuminous nature.

Then Dr. Weichart succeeded in isolating from the muscles of wearied animals a specific toxine, which, when injected in small doses into animals gradually produced immunity, and formed an antitoxine. In large doses the toxine produced all the symptoms of fatigue followed by death.

A more simple method of producing an antitoxine has been described by Messrs. Kalle and Co., in a recent German patent. According to their specification, when albumin is gently heated for about 10 hours with a chemical agent such as very dilute nitric acid, it is broken down into various products, one of which produces all the physiological effects of fatigue. On continuing the heating for a long period or on boiling the mass, this toxic substance is destroyed, and among the products of its decomposition is one that neutralises its action. This new substance may be separated from the other products of decomposition by dialysing it through a porous membrane, and from the accompanying mineral salts by extraction with acetone. When injected into the body it is stated to act as an antidote to the toxine of fatigue, preventing its injurious effects.

GEOLOGY.

By EDWARD A. MARTIN, F.G.S.

THE Council of the Geological Society has passed the following resolution:—"The Council of the Geological Society desires to express to the relatives of Professor H. G. Seeley, F.R.S., its profound sorrow in the death of one who had been a Fellow for nearly half a century, had frequently served on the Council of the Society, and, for so many years, continued to enrich the literature of Geology and Palæontology by numerous original researches in these Sciences."

A paper "On Labradorite-Norite with Porphyritic Labradorite," by Professor Johan H. L. Vogt, F.M.G.S., was read at the meeting of the Geological Society on January 13. The author dealt with a rock occurring at Napp Farm, on Flakstadö, off the northern coast of Norway. It contains 23 per cent. of labradorite-phenocrysts, in a crystalline groundmass made up of a more acid plagioclase, hypersthene, diallage, and titanomagnetite, with small quantities of biotite, and very little spinel, apatite, and pyrite. A little secondary hornblende and some garnet are present, but few other secondary products. Olivine is conspicuously absent.

The plagioclase-phenocrysts are more acid in their outer zones, and the groundmass plagioclase is still more acid as determined optically and by specific gravity and analysis. Analyses are tabulated of the bulk of the rock and the groundmass, and of the separated plagioclases and the magnetite. From these the relative proportions of the constituents are calculated, and the formula of the felspars determined; also the titanomagnetite proves to be a mixture of magnetite with ilmenite.

The order of crystallisation is found to be:—(1) Phenocryst plagioclase; (2) plagioclase with magnetite; and (3) plagioclase, magnetite, pyroxenes. The plagioclase-phenocrysts started to form at points from 8 to 18 centimetres apart, and when they had grown to some size a second crop of smaller crystals grew at nearer points; the magnetite was much aggregated round the plagioclase-phenocrysts, growing together with the plagioclase of the groundmass; and finally the remaining magma crystallised. The order of crystallisation is found to be consonant with the physico-chemical laws applying to the phase liquid-solid.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.MET.SOC.

The Remarkable Cold in December.—A spell of cold weather occurred during the last week of December, 1908. The cold was most intense on the 29th, 30th, and 31st. Minimum temperatures below 10° were registered at many stations in the Midlands, and also in the Southern and Eastern Counties. The lowest readings reported were:—−1° at Liphook, Hants; 2° at Brookwood and Chelmsford; 3° at Raunds, Northants, and Swarraton, Hants; and 4° at Beddington, Buxton, Halstead, and Marlborough. At the Royal Observatory, Greenwich, the minimum on the 30th was 12°.1, and the maximum was only 23°.3. This was the coldest day on record at the Greenwich Observatory for the month of December. The mean temperature on the 30th was 15°.9, which is 23°.0 below the average.

The Rainfall of 1908.—Dr. H. R. Mill has given in "Symons's Meteorological Magazine" and also in the *Times* a preliminary report on the rainfall of last year. He finds the following percentages of the average for the general rainfall of 1908:—

England, S.	...	86	Scotland	...	98
Wales	...	95	Ireland	...	101
England, N.	...	91	British Isles	...	93

This shows a close approximation to the average in Ireland, which had just perceptibly more, and in Scotland, which had just perceptibly less, rain than the average. Wales had distinctly less than the normal; and England, especially in the south, was very decidedly dry. England and Wales together had a deficiency of 11 per cent., but in the 28 years since 1881 seven have been drier in those divisions, viz.: 1884, 1887, 1893, 1898, 1901, 1902, and 1905.

Scientific Kites.—Mr. Eric S. Bruce, in a paper on "Some Forms of Scientific Kites," has brought to the notice of the Royal Meteorological Society some forms of scientific kites other than the well-known box-kite, invented by Mr. Hargrave. This is heavier and more breakable than many other forms of kites, but it possesses the indisputable advantages of stability, ascending steeply and exerting great force. When there is wind enough to fly it, it would appear unsurpassed. It is, however, advisable that meteorological kite ascents should be carried out as continuously as is possible, and that as many as possible of those days when the heavier box-kite will not rise should be utilised for obtaining information. On this account Mr. Bruce considers that lighter forms of kites which are specially adapted for use in very light winds, would be of great service. He then described the Brogden six-winged bird-kite, the Salmon eighteen-winged kite, the Barclay honeycombed kite, the Cody bat-winged box-kite, the Balston butterfly-kite, and the Burgoyne aluminium-kite.

XUM

The Royal Meteorological Society.—At the Annual Meeting of this Society on January 20, Dr. H. R. Mill, in his Presidential Address, spoke on "Some aims and efforts of the Society in its relation to the public and to meteorological science." After calling attention to the activity of the Society in the establishment of well-equipped and carefully inspected stations for accurate observations of meteorological phenomena, and to the effective work carried out by various special committees, he called attention to two lines of usefulness which lay open at the present time. One is the correction of the impulsive sensationalism and anti-scientific spirit in meteorological matters of a certain section of the Press of this country, which no doubt faithfully reflects the somewhat muddled ideas of the general public; the other is the advance which has been made in meteorological science during the last few years, and the new opportunities it brings. The first indicates a practical service to the public which we can render with our present knowledge, the second points to promising lines of advance along which our knowledge may be increased. Dr. Mill alluded to the popular errors which are current concerning published weather records, and the effect of these on the meteorological departments maintained by many municipalities. There seems to be a popular notion that sunshine is good, rain is bad; cold is bad; dryness is good; heat is good; and to be above the local average in the "bad" elements or below it in the "good" is a disgrace never to be acknowledged if it is possible to deny it. So much is this the case that instances have been heard of reports being suppressed in order to obviate misconception, and of instruments being moved in order to obtain more agreeable records.

Dr. Mill stated that we now stand at a very important point in the history of meteorology, which bids fair to expand in interest and importance in the twentieth century as chemistry did in the nineteenth, and from the same cause the increasing necessity of applying its principles to practical ends. The standpoint of the meteorologist to-day is different from that of fifty or even of twenty years ago. Then the only department in which much general interest could be expected or intelligent co-operation secured was climatology, the study of the average conditions of the atmosphere at different places. Much remains to be done in that department; but the main interest is being diverted from the stratum of air 4 feet above the ground on the study of which climatology has been based, to the vast expanses of the upper atmosphere miles above the abode of man. He believed that in a few years the "airy navies grappling in the central blue," will demand a far more exact knowledge than is now required of atmospheric circulation, of the relation of wind to gradient, of the disturbing influence of insolation on pressure, of the nature and movements of atmospheric eddies and currents, and these things becoming of practical importance it will become worth the while of wealthy people to find the means for studying them. Dr. Mill concluded by saying that the aims of meteorology and of the Royal Meteorological Society are not narrow, but as all-embracing as the atmosphere itself; and the efforts to fulfil those aims should be no less strenuous now than in the enthusiastic days when the Society was young.

The Samoa Observatory.—The Royal Society of Sciences of Göttingen has maintained a geophysical observatory at Apia, Samoa, since 1902. Originally established for a period of only fifteen months, chiefly with a view to obtaining seismological and magnetic observations synchronous with the observations of the German South Polar Expedition, the observatory soon proved to be so valuable that means were taken to prolong its existence for a further period of five years, and it now seems likely to be of a permanent character. The work of the observatory is grouped under four divisions, viz.—terrestrial magnetism, seismology, atmospheric electricity, and meteorology. The meteorological equipment includes, besides all the ordinary self-recording instruments, a complete outfit for kite-flying, and many successful kite flights have been carried out. The observatory is the headquarters of a network of some thirty climatological stations in Samoa, and may ultimately become the centre of a system of stations extending over all the South Sea Islands from the equator to lat. 35° S.

ORNITHOLOGY.

By W. P. PYCRAFT, F.L.S., F.Z.S., M.B.O.U., &c.

Destruction of Birds in Russia.—A writer in the *Field* (December 16, 1908) draws a lurid picture of the awful destruction which is taking place in the Arctic, Southern Caspian, and Ural Caspian regions of Russia, where the peasants raid the nests of swans, geese, ducks, and seafowl, with a thoroughness which is appalling. Large quantities of these eggs are used for food, and great numbers are disposed of to soap factories, or are given as food to pigs. But the numbers so used appear to form but a small proportion of the quantity collected, the rest being absolutely wasted or destroyed by dogs and herds of cattle.

While no one would object to the peasants in these inhospitable regions levying toll on these birds for the purpose of supplementing their scanty supplies of food, the senseless waste which they display is deplorable, and sooner or later will make itself felt all over Europe.

White-Tailed Eagle in Herefordshire.—A keeper at Tiberton has just achieved the splendid feat of killing a White-tailed Eagle! The bird, a female, weighing 10 pounds, fell to his gun on December 31, 1908; and from the description of Mr. James Pilly, was still in immature dress.

Crane in Northumberland.—Mr. W. Halliday writes to the *Field* (January 23) from Beal, Holy Island, to say that early in October, 1908, a crane was seen feeding in a stubble, and later on the mud-flats known as Fenham Stakes, on the mainland. Later it moved to the golf-links and sand-hills in Holy Island, where it was pursued, though, happily, unsuccessfully, by some local gunners.

Northern Marsh Tit in England.—*British Birds* for January contains an interesting note by Mr. W. R. Ogilvie Grant on the occurrence of the Northern Marsh Titmouse (*Parus borealis*), a specimen of which was shot at Tetbury, Gloucestershire, in March, 1907, by Mr. J. H. Paddock, who presented it to the British Museum, this being the first recorded occurrence of this race in the British Islands.

As Mr. Grant remarks, it is difficult to account for the occurrence of this bird in Great Britain, since, so far as is known, it is not a migratory species.

Osprey in Ireland.—An immature specimen of this species was, according to *British Birds* for January, captured on board a fishing vessel coming to Wexford, on November 1, 1908. It died, however, soon after reaching the shore.

Great Northern Diver in Summer Plumage in October.—Mr. J. W. Williams, in *British Birds* for January, records the fact that a fine specimen of the Great Northern Diver (*Colymbus glacialis*) was shot, in full summer dress, on the River Moy, Co. Sligo, on October 31, 1908. Not only did this specimen show no trace of winter plumage, but it was in better feather than specimens obtained in May.

Honey Buzzard in Co. Louth.—On October 31, 1908, we learn from *British Birds* (January), an immature male Honey Buzzard (*Pernis apivorus*) was shot near Ardee, Co. Louth, and being only slightly winged was sent to the Zoological Gardens in Dublin, where, however, it died a week later.

PHYSICS.

By PROFESSOR A. W. PORTER, B.Sc.

The Relative Intensities of Calcium Lines.—An interesting investigation has been made by A. S. King (*Astrophysical Journal*, December, 1908) on the variation of the intensities of several of the calcium lines as obtained by aid of a large electric furnace. The line λ 4227 is a well-known "flame" line. Sir W. Huggins and Lady Huggins have shown that when a minute trace of calcium is present in platinum or iron terminals of the electric spark, this line does not appear while the H and K lines of calcium are distinctly visible; while in low temperature flames, λ 4227 alone is visible.

In oxyhydrogen and very hot flames all three are visible,

but H and K are weak; the electric arc gives a similar gradation. These results seem to indicate that the intensities are governed largely by the temperature of the source. Experiments made by King, in which calcium was vapourised in a graphite resistance tube in an atmosphere of pure hydrogen, showed that under these circumstances the H and K lines do not appear; while when other salts are vapourised and calcium is contained as an impurity these lines are present; thus other determining factors are influential. The new experiments now made were devised with the object of testing the influence of changes of temperature under various conditions. The line λ 4227 has a strength which does not increase proportionately to the temperature, but is influenced very greatly by changes in the amount of calcium vapour present. The readiness with which it reverses in the arc is due to the strength with which the cooler outer layers of the arc radiate (and therefore absorb) this line. The production of H and K is more complex. High temperature alone (2500° C.) can produce them; their increase in strength is closely proportional to the temperature. Their reversal, in accordance with this, is usually narrow in the arc, the cooler regions emitting the lines only weakly. The lines widened slightly in the furnace with increase in vapour. In the main they may be regarded as temperature lines.

Refraction and Dispersion of the Argon Group.—Mr. and Mrs. C. Cuthbertson have recently (*Roy. Soc. Proc.*, Vol. 81, A 549) determined the refractive indices for various wavelengths of helium, krypton, and xenon, the method used being an interferometer one, and have expressed their results by means of the formula $\mu - 1 = a(1 + b/\lambda^2)$. The values of a obtained for the different gases are in still better agreement than previous ones were with the empiric ratios 1, 2, 8, 12, 20 (discovered by Cuthbertson) for helium, neon, argon, krypton, and xenon respectively. A further interesting relation is now found. If the values for b be plotted against the corresponding values for a, the points for He, Ar, Kr, Xe (neon has not been yet determined) lie nearly on a straight line. No theoretical reason for such an alignment has yet been found though it has been sought for. There is no doubt, however, that an extension of our knowledge of the relations between the optical properties of vapours is likely to lead to a revelation of the internal structure of the atom; and with this in view measurements of the dispersion are being made for other elements. These data are at present known only for very few. For oxygen and sulphur (which belong to the same column in a Mendeleef's series of the elements), the values of b are in the same ratio as the values of a, viz.: 1 to 4; but for nitrogen and phosphorus (which also belong to one column) the b's are as 1 to 2, while the values of a are again as 1 to 4. There is sufficient here to excite the imagination without satisfying it.

The Rebound of the Radioactive Gun.—The rebound of radium emanation, which must necessarily take place, if currently accepted views are correct, when an alpha particle is shot off is calculated by Messrs. Makower and Russ, in a letter to *Nature* (January 21), to be about 10 cms. per second. In seeking for evidence of this they find that if a brass plate be placed in a partial vacuum several centimetres distant from a frozen layer of emanation, the nearer side of the plate becomes much more radioactive than the upper side.

ZOOLOGY.

By R. LYDEKKER.

More About Marsupials.—In the last two numbers of this journal reference has been made to opinions emphasising the distinctness of marsupials from placental mammals; neither group, in the view of the naturalists cited, being the descendant of the other. In the November issue of the Quarterly Journal of Microscopical Science, a precisely contrary opinion is expressed by Professor Hubrecht, the well-known Dutch embryologist. In this article the author confidently announces "that the Didelphia [marsupials] furnish very conclusive evidence of their being very specialised descendants of the placental mammals." When specialists differ to this extent, it is very difficult for those unacquainted with the details of their particular lines of work to know what view to take. It may be noted, however, that Professor Hubrecht regards the placenta of the carnivora as of a primitive type, and that he also sees in the embryology of this order more or less distinct indications of affinity with the insectivora and marsupialia. This lends support to the view that the carnivora, as represented by the early Tertiary creodonts, are a very primitive group; and is also in harmony with the suggestion that has been made on palæontological evidence that carnivores and marsupials are related groups.

The Relationship of Lemurs.—The affinities of marsupials is, however, not the only point in which the Dutch Professor differs from some at least of his contemporaries. In an important memoir on the extinct lemur-like creatures recently published by the Zoological Society, two naturalists have expressed the opinion that it is no longer justifiable to separate, as an order or sub-order, the lemurs from the monkeys and apes; in other words, that the groups Lemuroidea and Anthropoidea are invalid. In this case Professor Hubrecht writes: "I must emphatically repeat that the case of the ordinal separation of the Lemurs from the Primates is one of crucial importance, and that, whatever inconvenience may in the present state of our knowledge be caused by it to palæontologists, we should on no account surrender or acquiesce to [*sic*] the proposal . . . . to keep separated the two orders of the Primates and Lemurs, and to use all our ingenuity and acuteness in order to trace, as new fossil remains come to light, remains belonging to the one and the other order by osteological differences alone." This is another case, with a vengeance, of doctors differing.

Fishes Derived from Land Animals.—It is difficult to take leave of Professor Hubrecht's article without referring to a theory therein suggested, which would be calculated to take one's breath away, or make one's hair stand on end, if we really took matters zoological seriously to heart. Taking as a starting point the fact that the descent of whales and dolphins, as well as of the extinct ichthyosaurians and plesiosaurians, from land animals is admitted by everyone whose opinion is worth anything, our author suggests that many fishes, whether referable to the dipnoan, ganoid, or teleostean groups, may likewise lay claim to a terrestrial ancestry. It is only right to say that Professor Hubrecht proceeds to admit that he is entering the domain of wild and hypothetical speculation; but, nevertheless, he definitely fixes upon the African bichir (*Polypterus*), a member of the ganoid group, as one which might well have had such a descent. Later on he observes that "I will not go so far as to say that all teleostomes and dipnoi have descended from terrestrial, air-breathing tetrapods, because the material upon which to base a similar conclusion is by far too scanty; but, on the other hand, I will not for the same reason anathematise any naturalist who feels inclined to go as far as that." It seems to me a matter for regret that the Professor has permitted himself to go even thus far on the road "of wild and hypothetical speculation," as it tends to weaken the value of his opinions on other matters; at any rate, I know that it does so in my own case. Professor Hubrecht has, however, done good service in emphasising the essential distinction which exists between sharks and rays on the one hand, and all other fishes, except lampreys, on the other, although I am scarcely yet prepared to follow him in dividing vertebrate animals into two groups, one represented by the lampreys, sharks, and rays, and the other embracing all the rest.

The Ancestry of Whales.—As so large a part of this article is devoted to the origin and relationships of various groups of animals, I may as well make a brief reference to the ancestry of whales, a subject which has recently been discussed by Dr. E. Stromer, in the *Anatomischer Anzeige* and also in the *Beiträge zur Paleontologie und Geologie Oster-Ungarns*. It need scarcely be repeated that the descent of whales and dolphins from air-breathing terrestrial mam-

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mals is almost universally admitted. For some years the idea was prevalent that the ancestral forms were to be sought among the primitive extinct representatives of the hoofed, or ungulate, group. There existed, however, during the Eocene division of the Tertiary period certain whale-like creatures known as zeuglodonts, and since their teeth are of a carnivorous type, it ought long ago to have been evident that if a kinship exists between these zeuglodonts and whales, the latter must have had carnivorous rather than herbivorous ancestors. As regards the zeuglodonts, discoveries made during the last few years in the lower Tertiary deposits of Egypt have almost conclusively proved that they trace their origin to that primitive extinct group of carnivora known as creodonts. The question accordingly narrows itself down as to the nature of the relationship (if any) existing between zeuglodonts and modern whales and dolphins.

In the opinion of Dr. Stromer the zeuglodonts are certainly to be regarded as primitive cetaceans, with a nearer relationship to the toothed than to the whalebone whales; such resemblances as they present to seals being due to adaptation to a similar mode of life. The larger species, which attained a length of some 30 or 40 feet, became extinct without leaving successors, as is commonly the case among animals; and although the smaller and less typical kinds present more approximation to the toothed whales, it seems probable that the two groups underwent a parallel development, rather than that the one is ancestral to the other. The distinction between the two is specially manifested by the hind-brain, or cerebellum, as well as by the form of the pterygoid fossa. On the other hand, the small zeuglodont known as *Protocetus* presents in its shorter snout and certain other features a more decided approximation to the toothed whales, especially some of their middle Tertiary representatives; and this suggests that modern whales are the direct descendants of some small, primitive, and, at present, unknown zeuglodont.

"Cuckoo-Spit."—Ever since the time when it was seriously regarded as an emanation from the stars or as the saliva of the bird from which it takes its name, there have been constant discussions as to the origin of the froth enveloping the "nymphs" of the homopterous insects of the family *Cercopidæ*, commonly known as "cuckoo-spit." Several naturalists have of late years tried to solve the problem, but according to an article contributed to the *American Naturalist*, none of them have been altogether successful. To test the matter thoroughly, the author inaugurated a very careful series of experiments and observations, in which the first process was to cleanse specimens of the nymphs from all traces of the investing froth by means of a camel-hair pencil, and then watch their actions when placed on twigs. When thus situated, the first action of the insect is to dig its beak firmly into the bark, soon after which its body will be observed to swell, while a little drop of clear liquid will be observed to issue from the vent. After a quantity of this fluid has accumulated about its body, the last, and sometimes also the second, pair of legs are moved to the region of the 7th and 8th abdominal segments, and rubbed against the body, as if in the action of mixing substances. After the fluid had been thus mixed so as to completely cover the body, the creature moved the tip of its abdomen out of the liquid, opening up the pair of lateral appendages of the 9th segment, which were again immediately closed. Then, with a downward movement, these parts were re-immersed in the liquid, when the appendages were opened and released a bubble of air in the liquid; and by the repetition of this process the insect soon became involved in a mass of the characteristic froth. Bubbles of different sizes can be made by regulating the size of the air-grasping pocket of the appendages. To complete the production of the envelope of froth, a mucilaginous substance is added from certain abdominal organs known as the glands of Batelli, this rendering the liquid viscous, and thus better adapted for retaining the air-bubbles. The problem thus appears at last to have been completely and satisfactorily solved.

Papers Read.—At the meeting of the Zoological Society held on January 12, Professor G. O. Sars communicated a paper on the copepod crustaceans of Lake Tanganyika, Professor E. A. Minchin discussed the flagellate blood-parasites of freshwater fishes, Mr. T. Goodey furnished a note on the goniadal grooves of a jelly-fish; the tuberculin-test, as applied to monkeys, with remarks on the temperature of mammals, formed the subject of a paper by Dr. A. E. Brown; and Professor R. Collett contributed notes on the hunting of the North Atlantic right-whale.

REVIEWS OF BOOKS.

ANTHROPOLOGY.

The People of the Polar North; a Record, by Knud Rasmussen, compiled from the Danish originals and edited by G. Herring. Illustrations by Count Harald Moltke (London: Kegan Paul and Co., 1908; £1 1s. net).—At the end of his Preface to Knud Rasmussen's charming book on the Greenland Eskimo, the editor says: "It is with the hope that it may please what is perhaps the most critical audience in the world that it has been launched on the troubled waters of English publicity." What is a critic to say after this? At all events, the present writer can assure both author, translator, and the public that the book has given him great pleasure and imparted no little information. The author has a complete knowledge of the language and a warm regard for the people, due partly to a strain of their own blood in his genealogy and partly to a sympathetic nature—a quality which is essential to a comprehension of a people. Unlike many travellers, Rasmussen is not afraid to let himself "go," and consequently we have a vivid picture of the hardships, privations and joys in a country which for a greater part of the year is buried in snow and subject to howling storms. The conditions of life are so hard that it is only by the exercise of great ingenuity and the practice of social virtues that human life is possible. The cheeriness, kindliness, and practical socialism of the Eskimo from Eastern Greenland to Alaska may be regarded as much due to their environment as is the necessity for eating large quantities of fat. The most novel and interesting section of the book is that dealing with the "Polar Eskimo, the most northerly dwelling people in the world," who wander from settlement to settlement between Cape York, North of Melville Bay, and Cape Alexander, approximately, therefore, between 76° and 78° N. latitude. The following quotations will give some idea of the author's descriptive powers: "The spring gales had blown themselves weary . . . the sudden thaw had reduced the hillsides to tears . . . the sun sailed hot across the heavens, and was so delighted at the approach of summer that he forgot to hide behind the horizon at all. . . . 'Things are beginning to wake up out there; the summer is coming!' the Eskimos say then. . . . There was growth in the very air, and unrest among men and women. Some of the young girls had flung off their clothes, and were playing catch on a flat open space; this roused the men to mirth too, and merrily they joined in the game. One old Eskimo had spread out a reindeer skin on the ground, and was revelling in the sunshine without a stitch upon him. By his side sat his daughter, in the same Edenic costume, nursing her little baby. Down on the seashore, at the edge of the ice, lay the dogs with tongues hanging out of their mouths, panting with the heat . . . everybody was happy." "The first dark evenings are hailed with the same glee as the first daylight, after the Polar night. Up there, as here, people like a change. When, a whole summer through your eyes have been bathed in light, day and night, you long to see the land vanish softly into the darkness again. . . . And with the idea of a change they associate the thought of all the good things the winter will bring with it; the frozen sea, and the hunting on the ice, and the swift sledge-drives, far from the sweltering houses, after bears. 'Ha! now the dark nights are coming, soon the ice will close in the sea!' the men cry, as they meet, towards evening. 'Be glad, for soon the blubber lamps shall light those who go out to fetch meat from the flesh-pits!' others call out. 'And windows and fires shall light far out into the night, and hasten the lagging pace of late-returning sledges!' adds another." The

student will be able to piece together a fairly complete picture of the life, ideas and ideals of these cheerful inhabitants of the far north, but he would have liked to possess more definite information concerning the regulation of marriage, kinship, social organisation, and other matters. The collection of folk-tales contains much incidental information concerning the psychology and habits of the narrators; students of folk-literature and of religious myths must study them to see how far they correspond with folk-tales of other peoples, but it appears at first sight that they resemble other folk-tales only to that degree that most folk-tales resemble each other; religious myths can scarcely be said to occur. The accounts of the West Greenlanders and the yet more modified East Greenlanders are of considerable interest. The book is sumptuously illustrated by plates and figures drawn by Count Harald Moltke. The dozen coloured plates are excellent, and most of the others are convincing portraits of Eskimo, which will prove of great value to those who are interested in racial traits; there are also numerous clever pen and ink sketches. Our thanks are also due to Mr. G. Herring for the able way in which he has edited and combined the two original Danish books. It is most satisfactory to learn that the intrepid and enthusiastic author is preparing to spend six years in a tour along the whole of the north coast of North America for the purpose of studying at first-hand the American-Eskimo, but the editor is scarcely justified in stating that "the Eskimo, as a race, are an unexplored and unexploited people." Let us hope they will always remain unexploited, but thanks to the labours of Professor Franz Boas and others, the Central and Alaskan Eskimo have been very well studied, though, of course, much remains to be done.

The Scope and Content of the Science of Anthropology; Historical Review, Library Classification, and select, annotated Bibliography; with a list of the chief Publications of leading Anthropological Societies and Museums, by Juul Dieserud, A.M. (Chicago: The Open Court Publishing Co.; London: Kegan Paul and Co., 1908; 8s. 6d. net).—The title and subsidiary title of this little book explain its scope. As the author has been Librarian of the Field Museum of Natural History in Chicago, which possesses a good collection of anthropological works, and subsequently a catalogue reviser in the National Library at Washington he has had to deal with anthropological literature, consequently he is well acquainted with anthropological bibliography. The first part of the book deals with the scope of anthropology as defined by numerous exponents of that science. In it the author gives in historical sequence, with a running commentary, the original and modified views of a considerable number of writers. In addition to its historical value, this section is interesting from a psychological point of view—not merely personal, but to a certain extent racial as well. In the second part the author adopts the following classification for bibliographical purposes: *Somatology* or *Physical Anthropology*, including Zoological anthropology or Anthropogeny, Paleoanthropology, Anatomical anthropology, Physiological anthropology, Racial psychology, Racial embryology, Racial pathology, Social physical anthropology (=criminal and mentally diseased), Systematic or Taxonomic anthropology; *Ethnical Anthropology*, including Ethnical or Folk-psychology, Ethnology or Culture anthropology (Ethnic sociology and Folk-lore and Sophiology), Archæology or Paleoethnology, Anthropogeography, Ethnography (Local somatography, Archæology, etc.). To each of these groups and their subdivisions numbers are given according to the decimal system now generally adopted in libraries. For practical purposes this classification will serve very well, especially as there are numerous blanks in which new subjects can be intercalated, but specialists will criticise the selection and order of many of the subjects. It would be tedious to attempt this in detail, and it must suffice to question the separation of Folk-lore and Sophiology from Ethnic sociology when Linguistics, Religion, and Mythology, and other great groups are included in the latter. Nor is the author logical in his smaller groupings, for why should the North and South American Indians have their Sociology, Religion, Technology and Art, Folk-lore, Customs, Ethics and Language enumerated, while the Old-World peoples have to be content with Somatography, Archæology and Folk-lore? Indeed, the classification of this section is very unsatisfactory. The third part is a selected bibliography with quotations or notes of contents, which are full of interest. The list of anthropological and ethnological societies and their publications is useful, but it would have been better to have included as well publications which do not emanate from societies, and under the former no mention is made of the publications of the Folk-lore Societies of Great Britain, America, etc. The list of leading Ethnographical Museums and Museums containing important Ethnographical collections is woefully incomplete. To take a few cases that occur to me—no mention is made of the Pitt Rivers Museum at Oxford, the Cambridge Ethnological Museum, the Museums in Adelaide, Brisbane, Batavia, Sarawak, Colombo, and in numerous other towns. The book has its merits and is useful up to a certain point, but it is by no means the last word on the subject.

ASTRONOMY.

Annals of the Astrophysical Observatory of the Smithsonian Institution, Volume 2, by C. G. Abbot and F. E. Fowle (Washington, 1908; pp. vii. and 245, with plates).—The present volume contains researches on solar radiation, including and in continuation of those undertaken by the late Professor Langley, and for their scope we can hardly do better than quote the words of the authors, who say, "The present volume is an account of the work of the Astrophysical Observatory from 1900 to 1907, with details of the investigations made, the apparatus and methods used, and the results obtained. Speaking broadly, the investigation relates to the intensity of the rays of the sun and the dependence of the earth's temperature thereon. The subject is treated in three parts. First, the amount of the solar radiation as it would be if measured outside the earth's atmosphere, at mean solar distance, or, as it is often termed, 'the solar constant of radiation.' Second, the dependence of the earth's temperature on the amount of solar radiation. Third, the difference in brightness between the centre and edge of the sun's disc and its relation to the quantity of solar radiation received by the earth." From such a main programme naturally spring such investigations as to what extent is the use of the word *constant* justifiable in reference to solar radiation, and for this records from nearly fifty stations distributed over the earth and obtained during the last thirty years have been examined. Again, some measures were taken at Washington near sea-level, others at Mount Wilson at about 6,000 feet elevation, and, consequently, absorption at different wave-lengths has shown that the atmosphere of the earth is not equally transparent for all rays. Hence the absorption, or diffuse reflection, of the air and the reflecting power of the clouds have also demanded investigation. It appears, however, that in regard to the reflecting power of clouds the authors' method of treatment does not commend itself to Professor Olmsted, of the Carnegie Solar Observatory, and in consultation with him they have since published a modification of their conclusions. The solar "constant" they give as 2.1, whereas Langley made it about 50 per cent. greater, but they explain away the discordance, maintaining it to be due to an unjustifiable correction applied by him to a result which really agreed absolutely with theirs to the first decimal place (2.14 to be exact, theirs being given as probably greater than 2.05). The word "constant" they find to be merely conventional, and they show evidence of variation with the sun's distance in addition to changes which they think must be of solar origin. As will be readily divined, there is much more of great interest in the volume, which is a valuable contribution to a very difficult and highly interesting subject, verging on the confines of scientific meteorology, though also of undeniable astronomical bearing.

44e Année, Annuaire Astronomique et Météorologique pour 1908, par Camille Flammarion; Illustré de 88 Figures, Cartes et Diagrammes; prix 1 fr. 50; 287 pp.—There is a mass of valuable information included in this annual, in addition to the usual data expected in an almanac, ranging from a "concordance of calendars," including the Gregorian

Julian, Republican, Jewish, Mussulman and Chinese; a perpetual calendar, and a table to give Easter for 600 years, to a comparative study of seasonal mean temperatures from 1886, and tables of extreme annual temperatures at Paris from 1699, and rainfall, not quite complete, from 1689. We find instructions on the use of instruments for amateur astronomers, a complete review of the progress of astronomy during the year 1907, and an equally complete meteorological summary for Juvisy in 1906. A dissertation on Paris rainfall is of especial interest. M. Flammarion points out the undeniable increase in Paris rainfall during the last century or two, and in order to test the suggested cause (increase of smoke from factory chimneys), cites the available figures for Greenwich, which show, if anything, a decrease of annual rainfall, thus negativing the factory suggestion and leaving the question still unsettled.

BOTANY.

The Heredity of Acquired Characters in Plants, by the Rev. Professor George Henslow, M.A. (London: John Murray, 1908; 6s. net). The reverend Professor has undertaken to prove that "evolution—so far as plants are concerned—depends upon the inheritance of acquired characters." Presumably the arguments advanced are considered not applicable to the animal kingdom, hence the saving clause, "so far as plants are concerned"; if so, I am afraid the author stands alone in suggesting a special set of fundamental laws governing the evolution of the plant and animal kingdoms respectively. Weismann's theory is demolished in the first paragraph of the preface, as follows: "As all the characters of the vegetative system, or the source of plants, which are regarded as specific, are acquired long before any reproductive organs exist at all, and therefore before any vegetable cell has begun to assume a reproductive character, Dr. Weismann's proviso is inapplicable to plants." Weismann's proviso referred to appears to be his conception that characters cannot be hereditary unless the influence of the environment is embodied in the germ-plasm. The author considers that the study of plants now called ecology, conclusively proves that the evolution of plants is a natural response to the direct action of changed conditions of life, and, furthermore, that these acquired conditions can become hereditary. Granting this, we fail to gather any evidence from the arguments submitted, that the acquisitions or modifications enumerated are not embodied in, and transmitted through, the "germ-plasm." The proof of a hereditary tendency cannot be demonstrated in the lifetime of a given individual, hence any modifications manifesting themselves in an individual, must, in the ordinary course of events, be embodied in the seed or germ-plasm, if such modifications show themselves in the next generation. The arguments derived from cultivated plants are not admissible, as it is a matter of everyday experience that, unless such plants are kept up to the mark, artificially imposed changes are fleeting, and if such plants are neglected they gradually revert to old-time customs and habits. Notwithstanding differences of opinion, the book under consideration contains a mine of information, and should be carefully studied by all interested in the subject of evolution. The many excellent illustrations greatly aid in clearly grasping the author's contentions.

A Text-Book of Botany, by J. M. Lowson, M.A., B.Sc. (University Tutorial Press, Ltd.; 6s. 6d.).—The issue of a fourth edition proves that this book meets the requirements of a goodly number of students. It is perhaps more especially adapted for those who have no option but to take a botanical course, as in reality it would be better described as an encyclopædia than a text-book. Several important additions appear, more especially a chapter on "Ecology and Plant Distribution." The chapters on "Physiology" have also been revised. The illustrations are numerous and generally good.

Elementary Botany, by Percy Groom, M.A., D.Sc. (London: Bell and Sons; 3s. 6d.).—The additions to the eighth edition of this well-known text-book include chapters on "Form and Function," and "Soil and the Distribution of British Plants," also a number of additional notes interspersed in the text. These additions serve the admirable purpose of indicating that a plant is not a unit, but simply one cog in the wheel representing the vegetable kingdom, an educational point of primary importance. The 270 figures are perhaps unequalled in any text-book extant.

CHEMISTRY.

Laboratory Manual of Qualitative Analysis, by Seger Clone, A.B. (London: Longmans and Co., 1908; pp. xii. and 136; 3s. 6d.).—This is an excellent little book, which, while thoroughly concise, is so arranged that it is almost easier for the student using it to ask himself the reason for each step of practical work than to follow blindly the directions. It opens with an introduction on the general principles of analysis, and then gives schemes for the detection of bases, acids, and salts, and concludes with a section containing systematic questions upon the other portions. Some previous acquaintance with analytical chemistry is necessary, for the scheme of this book is to supplement the work of the teacher rather than to take his place.

NATURAL HISTORY.

Animal Romances, by Graham Renshaw (London: Sherratt and Hughes, 1908; pp. vi. and 206; 6s. net).—The author of this attractive volume has hitherto been best known to the public as a writer of several series of interesting essays on animals in menageries and exterminated species. He now reveals himself in a new phase, as one who has travelled much in distant lands—especially Africa, and has made excellent use of his time in photographing wild animals in their native haunts. In some cases the reproductions from these photographs are excellent, but in others they are somewhat blurred. Although the author appears quite unaware of the fact, the one facing page 57 is of special interest as showing a young eland with its horns directed outwards. Such a form is often considered by sportsmen as indicating a distinct race, although it is of course nothing more than a phase of growth. In connection with the banting, or bantin, it should have been mentioned that the photograph represents the domesticated breed reared in Bali, and not the true wild ox of Java; it is also a little misleading to say that this animal is a native of Burma, as its Burmese representative, the tsaine, is very different. The style of the letterpress is a little flowery, and we prefer to call a giraffe a giraffe rather than a "dream creature," but this is a matter of taste; and we have no hesitation in saying that Mr. Renshaw has succeeded in producing a very attractive Christmas gift-book.

ORNITHOLOGY.

How to Attract and Protect Wild Birds, by M. Hiesemann (London: Witherby and Co., 1908; 1s. 6d. net).—That birds of many species can be induced to rear their young in artificial nesting-places has long been known. Commercially, indeed, this knowledge has been taken advantage of, in the case of certain species of ducks, from time immemorial. But only of late years has the practice come into vogue of erecting nesting-boxes in suitable sites for the use of Passerine and other small species; and, happily, it is steadily growing. Thereby the numbers of species useful to man may be materially increased, though these harbours of safety are commonly put up for the mere delight of attracting as many species as possible to take up their quarters in our gardens and pleasure grounds. But we regret to find that there are those who have adopted the practice of putting up nesting-boxes for the purpose of obtaining birds on a large scale for ultimate disposal as cage-birds. We have just learned that a man in one of the Midland Counties in this wise annually obtains hundreds of specimens for the live-bird trade. This base abuse of an excellent custom is, however, we know of but rare occurrence. On the Continent, especially in Germany and Austria, this good custom of bird-fostering is carried out in a fashion as yet unknown in this country. The practice of aviculture, in short, is made something more than the breeding of birds in confinement. There are a number of birds, for example, of the highest value to aboriculture, agriculture, and horticulture, which could never be induced to breed in nesting-boxes. To foster the increase of such birds, natural breeding-sites must be provided. And how this can be done has been demonstrated on a magnificent scale by the Baron Von Berlepsch. On

his estate at Seebach, many acres of land are set apart to form a sanctuary wherein warblers, woodpeckers, tree-creepers, and so on may nest in peace. The ground thus consecrated, however, is not, as might be supposed, allowed to become a jungle. On the contrary, it has been most sedulously planted and pruned, so that the undergrowth has been made to yield the maximum accommodation for nests, while the utmost care has been displayed in the distribution of nesting boxes among the trees. More than this, during the winter months, which are severe in Germany, provision is made to ensure a bountiful supply of food to all the resident species, and hereby a great mortality is avoided. Aviculture of the kind practised by Baron Berlepsch is, unfortunately, unknown in this country, but if we read the signs of the times aright the day is not far distant when some such schemes will be set on foot on more than one estate where the value and importance of economic ornithology is fully realised. For the benefit of these pioneers we venture to draw attention to this little volume. Herein will be found a most careful summary of the valuable work which Baron Berlepsch has been carrying on for some years past on his estate at Seebach. Space forbids us entering into a more particular account of the contents of this volume, and similarly we are unable to comment on the striking proofs he gives of the vast importance of this work of bird preservation in relation to Forestry and Farming. The price of the book is so small as to be within the reach of all who are really interested in the study of our native birds.

ZOOLOGY.

The Origin of Vertebrates, by W. H. Gaskell (London: Longmans, Green, and Co., 1908; pp. xi. and 337, illustrated; 21s. net).—To do adequate justice to a work which demands so much close attention on the part of the reader as does Dr. Gaskell's volume, is an absolute impossibility in the limited space at our command; and we can do little more than express our admiration of the originality and ingenuity displayed by the author in inventing clever theories to explain his facts. Dr. Gaskell is primarily a physiologist, and a physiologist of no mean repute; but for many years past he has made the fascinating subject of the origin of vertebrates a pet hobby. On this subject he has already published a considerable number of papers, the pith of which is reproduced in the volume before us; and, whether we accept his conclusions or not, there can be no question as to the great advantage of having this between two covers. Having, apparently, no doubt that vertebrates are derived from some group of invertebrates, the author (like the rest of us) has been puzzled how to harmonise the different relations of the neural and digestive systems of the two groups. He attempts to solve the problem by the theory that the brain and spinal cord of the vertebrate represent the invertebrate intestinal tract; the hollow in the cord being the remnant of the original intestinal tube. That the theory is highly ingenious, and original to the last degree, must be admitted by all; whether it is anything more than this, must be left to specialists and the future to decide. To what extent the author's view with regard to vertebrate ancestry depends on the acceptance or rejection of this theory is a little difficult to glean. Be this as it may, in Dr. Gaskell's opinion, the ancesters of vertebrates are to be found in that group of primitive palæozoic creatures comprising the giant scorpions, or eurypterids, and trilobites, whose nearest relatives he believes to be the modern king-crabs. From these sprang the armoured fish-like pterichthys and its relatives (the two groups constituting the Palæostraci), and from these again the most primitive true fishes. This theory of the origin of vertebrates from a "palæostracan" stock affords no clue to the relationships of the tunicates and enteropneusta (*Balanoglossus*), but in the author's opinion, neither the former of these nor the lancelet are on the direct line of vertebrate descent. In the case of the enteropneusta, Dr. Gaskell doubts indeed whether they have any claim to direct affinity with the vertebrate stock.

Experimental Zoology: Part I. Embryogeny, by Hans Przibram (London: Cambridge University Press, 1908; pp. viii. and 124, illustrated; 7s. 6d. net).—This work is an English translation, by Miss Sollas, of a first-class German biological treatise, which is itself a development of the latest edition of the author's "Introduction to the Experimental Morphology of Animals." The new work is in fact an expanded edition of the latter with the addition of a large number (16 in the present part) of exquisite coloured plates. This, of course, entailed a very serious addition in price, and in order to mitigate so far as possible the effects of this rise it was resolved to issue the work in parts, each of which should be virtually complete in itself. The present part, which is devoted to an account of the laws governing the development of the animal egg as ascertained by experiment, seems to contain all the information that the student can possibly desire, and if the succeeding parts follow the same lines, the work will be exhaustive.

MISCELLANEOUS.

A History of Painting in Italy, by J. A. Crowe and G. B. Cavalcaselle. Edited by Langton Douglas, Vol. III. The Sienese, Umbrian, and North Italian Schools (London: John Murray, 1908; 21s. net).—Crowe and Cavalcaselle's "History of Italian Painting" remains indispensable to the serious student of art. It had long been out of print, when, in 1903, Mr. John Murray republished the first two volumes. The first instalment of this invaluable book was eagerly welcomed in its new form, for not only had Sir Joseph Crowe himself made considerable additions and emendations for a proposed new edition before his death, but it had been entrusted to the able editorship of Mr. Langton Douglas and Mr. Arthur Strong, who had added in the forms of footnotes and appendices such qualifying statements as modern discovery required. The much-to-be-regretted death of Mr. Arthur Strong, combined with other causes, has deferred the arrival of Volume III. until now, but its tardy appearance makes it none the less welcomed by those who wish to correct their own impressions, or refresh their memories at the supreme tribunal of art connoisseurship. Nearly two-thirds of Volume III. are devoted to the early Sienese painters—those artists whose strangely subtle and elusive charm is so distinct from that of any other school. Duccio had already received some attention from the editors in Volume II., where he appears in connection with Cimabue, who was there bereft, according to modern criticism, of his most popular masterpiece, the Ruccellai Madonna. In Volume III. the opening pages are occupied by Duccio, who, though "he remained true to old typical forms and methods, was the most dramatic artist that Siena had produced, rivalled in force only by the Lorenzetti, and in grace only by Simone." It was this same Simone Martini of whom Petrarch said: "I have known two painters, talented both, and excellent—Giotto, of Florence, whose fame among the moderns is great, and Simone of Siena." Vasari ascribed to him the authorship of the frescoes in the Spanish Chapel, one of that historian's many errors which the authors corrected. Visitors to Siena will at once recall this painter's immense frescoe of the Madonna and Child and Saints, "Like a fair piece of tapestry or a magnificent miniature," in the Palazzo Communale. They will also recall the "Majesty" of his relative and partner, Lippo Memmi, who decorated the Council Chamber at San Gimignano with a fresco in emulation of that of Siena. The Lorenzetti occupy nearly the whole of Chapter II., in which an important appendix is here interpolated by Mr. Langton Douglas on Andrea di Bartolo, son of the well-known Bartolo di Fredi, who painted the curious Birth of the Virgin in San Gimignano, an "artist who has been entirely forgotten by modern art critics, and whose signed works have been given to other painters." Later chapters deal with the less-known artists of the Umbrian and Bolognese Schools. In Chapter VI. much space is devoted to the work of the little generally known but very interesting painters Aticchiero and Avanzi. The concluding pages deal with the early painters of Venice, where painting remained crystallised and did not develop till the middle of the fifteenth century. Let us earnestly hope that a very short time only may elapse before Mr. Murray is able to publish the concluding volumes.

XUM

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, M.A., F.R.M.S.

The Preparation of Microscopical Objects.

(*Continued from page* 38.)

WE have now to deal with a very important and useful class of stains which are derivatives of coal-tar products, and are known as such. These stains are generally easy to use, and give good results, though the results are not always as permanent as could be wished. They combine readily with the tissues and seldom require the use of a mordant, but give their best results in most cases when the tissues are over-stained, and the excess of colour is removed. This, as explained in a previous paper, is an example of the "regressive" method of staining, by which sharp differentiation is most easily obtained. Otherwise these stains tend to be somewhat diffuse. The number of coal-tar stains in use is considerable and is growing, but as these papers are meant to explain principles rather than detailed methods I shall content myself with mentioning only a few of those most commonly in use. Of these, two, Methyl Green and Bismarck Brown, may be looked upon as acting best when allowed to stain *progressively*.

Methyl Green.—A suitable formula would be:—

Methyl Green	0.5 gram.
Acetic Acid	1.0 c.c.
Rectified Spirit	20 c.c.
Distilled Water	80 c.c.

Stain for about five minutes, rinse thoroughly with slightly acidulated distilled water, if necessary differentiate rapidly with 90 per cent. alcohol also slightly acidulated, and mount in glycerine, glycerine jelly, or Farrant's solution. This stain is most useful for fresh tissues, particularly botanical ones, and it attacks chromatin in particular. It is, therefore, a nuclear stain. Mr. Lee calls attention to its sensitiveness to the action of alkalies, and rightly lays stress upon the necessity of seeing that all solutions for washing or mounting are neutral or faintly acid. It is an advantage if the stain is made up with a little acetic acid, as in the formula given above, and all washing and dehydrating media must also be slightly acidulated. The glycerine or Farrant's solution used as the mounting medium must be made very slightly acid too. The stain acts almost immediately and is very penetrating, but there is little tendency to over-stain. It is not easy to mount in Canada balsam, as the stain comes out very rapidly in the alcohol necessary for dehydration, and in aqueous media, as above, the stain unfortunately fades rather rapidly, so that it is not suitable for really permanent preparations.

Bismarck Brown (*Vesuvin*).—This is a useful nuclear stain for either fresh or hardened tissues. It is, perhaps, most conveniently made up as follows:—

Bismarck Brown	0.5 gram.
Rectified Spirit	20 c.c.
Distilled Water	80 c.c.

or it may be made up as a saturated aqueous solution for *intra-vitam* staining. It is not easily washed out, and is permanent, but stock solutions are best filtered just before use. Like methyl green it stains quickly, but does not over-stain. The stain is used *progressively*, and the tissues may be mounted either in aqueous media such as glycerine, or in Canada balsam.

(*To be continued.*)

Royal Microscopical Society.

December 16, 1908.—Conrad Beck, Esq., Vice-President, in the chair. Mr. J. E. Stead, F.R.S., read the following papers:—"On a Workshop Microscope for the Examination of Opaque Objects," and "On a Simple Method of Illuminating Opaque Objects," specimens of microscopes and of the electric light fixed to the object-glasses, with portable battery attached, being exhibited in illustration. He also described and illustrated some simple methods of mounting irregularly-shaped pieces of metal, one side of which had been faced for microscopical examination. The Rev. Eustace Tozer read a paper on "Mounting Rotifers and *Protista* in Canada Balsam," which he illustrated by a number of specimens exhibited under microscopes in the room, including *Brachionus, Floscularia, Hydatina, Œcistes, Pterodina Euglena*, ciliated embryo of *Membranipora pilosa, Polytoma uvella*, etc. The Chairman then declared the meeting "Special" pursuant to a notice given at the last meeting on the requisition of 11 Fellows of the Society, and Mr. D. J. Scourfield moved that the by-laws of the Society be altered to admit women to the meetings of the Society, a privilege from which women Fellows of the Society have been hitherto debarred. A long discussion followed, in the course of which arguments were advanced against the proposed change, mainly on the ground that the presence of ladies would act as a restraint on the meetings, and it was finally agreed that a special committee be appointed to consider the matter and report to the Society, and to circularise the Fellows of the Society with a view to ascertaining their wishes on the matter.

Quekett Microscopical Club.

January 1, 1909.—Mr. A. Earland gave a lecture on "The Selective Power of Arenaceous Foraminifera," illustrated by specimens exhibited under upwards of twenty binocular microscopes. The majority of the preparations were selected from the lecturer's own dredgings taken during the last two years in the North Sea and North Atlantic. Having regard to the extremely limited powers of locomotion in the Foraminifera it might be thought that there would exist great similarity of test in different forms living in one locality and under identical conditions. This, however, is not the case, and nearly every species has well-marked characteristics which serve to distinguish its test from those of closely allied forms. Thus, one form has the wonderful power of selecting for use only large grains of sand, but will cement them together very roughly. Another species will use grains of similar size, but will form a sphere of practically smooth surface. Other species will select sponge spicules from the mud and will cement these side by side to form a thin shell wall, or will mat them together with fine sand and mud; while somewhat similar structures are built by caddis larvæ and by *Melicerta*, yet these have organisation and structure as far above the Foraminifera as man is above them. Among the most interesting of the preparations exhibited may be mentioned *Crithionina pisum*, Goës var. *hispida*, Flint; *Haliphysema Tumanowiczii*, Bowerbank, from a colony parasitic on a Zoophyte, Pegwell Bay, and several species of *Technitella*, including one as yet undescribed from the North Sea, 73 metres.

Journal of the Quekett Microscopical Club.

The November issue of this Journal (published twice

a year) contains an article by Mr. A. E. Hilton "On the Cause of Reversing Currents in the Plasmodia of Mycetozoa," giving an account of the physical and physiological phenomena of the movements observable in Mycetozoa; Mr. C. D. Soar, F.R.M.S., describes the genus of water-mites now included under the name *Hydrachna*, illustrated by a plate; Mr. W. Wesché, F.R.M.S., describes the proboscis of the blow-fly (*Calliphora erythrocephala*) with two beautiful plates; Mr. T. B. Rossiter contributes an excellent description of the tape-worm (*Hymenolepis farciminalis*) with, of course, especial reference to the genitalia, illustrated by a plate; and Mr. F. P. Smith describes some British spiders taken in 1908, also illustrated by a plate. Finally, Mr. C. F. Rousselet, F.R.M.S., contributes a note and drawing of a new rotifer, *Notholca Bostoniensis*, taken at Boston, U.S. The rest of the Journal is taken up with the proceedings of the Club, which have been summarised each month in "KNOWLEDGE."

Microscopical Material.

I have received from Mr. J. B. Bessell some Barbadoes Earth for distribution. The earth will, of course, require some preparation before it can be used, and Mr. Bessell has, therefore, been good enough to send me the following note on the method which he has found most efficacious:—

"The cleaning of Diatomaceous Earth is both difficult and disagreeable, and should not be undertaken unless proper facilities can be provided for carrying off the noxious fumes of the boiling acids. Also care must be taken not to spill any of the acids on the hands or clothes, and it is not advisable to stand near, as the acids have a tendency to boil up suddenly, with small explosions; but with reasonable care an accident may be avoided.

"Take three or four pieces of the earth, each as large as a pea or thereabouts, and boil in a strong solution of common washing soda, stirring it from time to time with a glass rod until all is broken down into a fine mud. Then pour the whole into a beaker of clean water and allow it to settle for about a couple of hours; pour off the water and refill with fresh water, stir it well, and then allow it to settle again. This must be repeated three or four times until all trace of the soda has been removed.

"Boil the sediment well in strong nitric acid for about 20 minutes, adding from time to time a little hydrochloric acid; wash as before with plenty of water to free the sediment from all trace of soluble lime, salts, etc., and then boil in strong sulphuric acid, adding from time to time a few grains of chlorate of potassium. Again wash away thoroughly all traces of the acid, and boil in a strong solution of ammonia. Again wash thoroughly and boil the sediment, now greatly reduced in quantity, in clean water. Wash two or three times in distilled water and separate into various densities by fractional decantation.

"The diatoms are chiefly of the genus *Coscinodiscus*. Of these germs there are two easily recognised species, viz., *Coscinodiscus excavatus*, Grev., around the centre of which are two or three alternate rounded elevations and depressions, and *Coscinodiscus superbus*, Hardman = *Cestodiscus pulchellus*, Grev., of which the central marking is pearly with a broad, distinct band of fine puncta and a row of prominent apiculi at the inner edge of the band. Several other genera are represented sparingly as well as many beautiful Polycystina."

Applications for this material must be accompanied by a stamped, addressed envelope and by the coupon to be found in the advertisement columns of this issue of "KNOWLEDGE."

Notes and Queries.

Insect Preparations.—Messrs. Clarke and Page, of 104, Leadenhall Street, E.C., have sent me a specimen of a class of slides which they inform me they have paid much attention to for some time past, *i.e.*, the mounting of various insects and insect-parts, more especially the heads and mouth organs, without pressure. The slide sent me was of the head and mouth organs of the honey-bee (*Apis mellifica*), mounted for opaque or annular illumination, and was a really beautiful example of what can be done in this way. Messrs. Clarke and Page send me a list of many other similar preparations in stock, and inform me that these are similar to the beautiful preparations of Mr. Fred Enock, and that they are quite permanent and uniform in finish. The prices are very moderate, varying from 1s. to 2s. each. Messrs. Clarke and Page also make a speciality of photo-micrographic lantern slides of insect and other preparations.

New Catalogues.—Mr. Chas. Baker sends me the 1909 edition of his catalogue of microscopes and apparatus, to which I have before called attention for its lucid and orderly arrangement. It is more than a price-list of this maker's own goods, as it contains classified lists by other and competitive makers, so that a purchaser has every opportunity of comparing prices and value given. The section devoted to dissecting lenses and apparatus, microtomes, etc., is very complete, and a detailed list of Grübler's and other stains and media is of much service to all serious workers. Nearly all these stains are in stock in London, a matter of no little moment to the busy expert. A further feature is a very complete list of bacteriological hæmatological and other apparatus for clinical and pathological work, and lists of slides, in series and otherwise, with special reference to definite courses of study. Some of my readers may not be aware that Mr. Baker has a special slide-lending department at a moderate inclusive fee. Messrs. Ross, of New Bond-Street, send me a list of microscopes and accessories of their own make. Messrs. John Wheldon and Co., of 38, Great Queen Street, send a catalogue of botanical books, containing some 800 books and papers concerning the Cryptogamia. This firm makes a speciality of books dealing with all branches of natural science, and their catalogues invariably contain interesting items. Messrs. A. E. Staley and Co., of Thavies' Inn, E.C., the London representatives of the Bausch and Lomb Optical Co., of America, send me a recent number of a little 16-page monthly publication issued by the latter firm, entitled the "Prism," dealing in a popular way with the manufacture of the microscope, of which they will be pleased to send a copy to any reader who may be interested.

H. F. Angus and Co.—I have received an advance copy of a circular and catalogue of this firm, who are newly established at 83, Wigmore Street, Cavendish Square, London, W., as manufacturers, importers, and exporters of scientific instruments. Mr. Angus was recently manager for Mr. Chas. Baker, and was, I believe, responsible for the excellent and scientific arrangement of the catalogues of this firm, which I have frequently commended in these columns. Messrs. H. F. Angus and Co. supply nearly all kinds of scientific instruments, especially microscopes and accessories, both of English and Continental make, but my main object in writing this note is to call attention to a series of demonstrations that will be given at the foregoing address, or elsewhere by arrangement, on the manipulation and use of the microscope and its accessories. These demonstrations are free to all who care to attend, and will be arranged at times suitable to them, each demonstration being complete in itself and lasting about one hour. They include "The visibility of an object dependent on aperture; the utilisation of aperture; the testing and comparison of objectives; optical methods of increasing the visibility of very transparent objects, various methods of illuminating opaque objects; and apparatus for recording observations." Those interested should communicate direct with Messrs. H. F. Angus and Co.

[Communications and inquiries on Microscopical matters should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge. Correspondents are requested not to send specimens to be named.]

XUM

The Face of the Sky for February.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 7.42 and sets at 4.46; on the 28th he rises at 6.48 and sets at 5.35. Sun-spots may occasionally be observed, though they are not very numerous. At the time of writing two groups are visible on the disc. The positions of the Sun's axis, centre of disc, and heliographic longitude are given below:—

Date.	Axis inclined from N. point.	Centre of Disc S. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
Jan. 31 ..	11° 52′W	6° 2′	174° 37′
Feb. 10 ..	15° 47′W	6° 39′	42° 56′
,, 20 ..	19° 9′W	7° 4′	291° 15′
Mar. 2 ..	21° 56′W	7° 14′	139° 32′

THE MOON:—

Date.	Phases.	H. M.
Feb. 5 ..	○ Full Moon	8 25 a.m.
,, 13 ..	☾ Last Quarter	0 47 p.m.
,, 20 ..	● New Moon	10 52 a.m.
,, 27 ..	☽ First Quarter	2 49 a.m.
Feb. 8 ..	Apogee	5 18 a.m.
,, 20 ..	Perigee	11 24 p.m.

OCCULTATIONS:—

Date.	Star's Name.	Magnitude.	Disappearance.		Reappearance.	
			Mean Time.	Angle from N. point.	Mean Time.	Angle from N. point.
			p. m.		p. m.	
Feb. 3	μ^1 Cancri	6·2	6 29	87°	7 39	277°
,, 27	105 Tauri	5·8	6 47	134°	7 31	201°

THE PLANETS.—Mercury (Feb. 1, R.A. $22^h\ 0^m$; Dec. S. 10° 33′. Feb. 28, R.A. $21^h\ 5^m$; Dec. S. 15° 30′) is in inferior conjunction with the Sun on the 11th; after this date the planet is a morning star in Capricorn, rising at 6 a.m. on the 24th.

Venus (Feb. 1, R.A. $19^h\ 29^m$; Dec. S. 22° 1′. Feb. 28, R.A. $21^h\ 48^m$; Dec. S. 14° 29′) is a morning star in Capricorn, rising at 6.42 a.m. on the 14th. The planet is not suitably placed for observation and is diminishing in brightness. In the telescope, the planet appears nearly at "full," 0·95 of the disc being illuminated, with an apparent diameter of 10″.

Mars (Feb. 1, R.A. $16^h\ 54^m$; Dec. S. 22° 26′. Feb. 28, R.A. $18^h\ 13^m$; Dec. S. 23° 39′) is visible in the mornings, rising about 4 a.m. on the 14th. The planet is situated in Sagittarius, but appears as an inconspicuous star; the apparent diameter being only 5″.

Jupiter (Feb. 1, R.A. $10^h\ 59^m$; Dec. N. 7° 58′. Feb. 28, R.A. $10^h\ 47^m$; Dec. N. 9° 15′) is a brilliant object in the evening sky looking South-East. The planet is in opposition to the Sun on the 28th, hence about this date he appears South at midnight. On the 14th the planet rises at 6 30 p.m., thus being visible throughout the night. The equatorial diameter on the 15th is 43″·8, whilst the polar diameter is 2″·8 smaller; this polar flattening is a conspicuous feature of Jupiter, and is readily observable in small telescopes, also the attendant bright moons and belt markings on the planet's disc form interesting objects of observation.

The following table gives the satellite phenomena visible between 7 p.m. and midnight:—

Date.	Satellite.	Phenomenon.	P.M.'s H. M.	Date.	Satellite.	Phenomenon.	P.M.'s H. M.	Date.	Satellite.	Phenomenon.	P.M.'s H. M.
Feb.				Feb.				Feb.			
1	III.	Ec. D.	10 56	12	I.	Tr. I.	11 22	21	I.	Tr. I.	7 32
4	I.	Ec. D.	11 49	13	I.	Ec. D.	8 11		I.	Sh. E.	9 40
5	I.	Sh. I.	9 5		I.	Oc. R.	10 48		I.	Tr. E.	9 50
	I.	Tr. I.	9 37	14	I.	Sh. E.	7 46	22	II.	Sh. I.	10 19
	I.	Sh. E.	11 24		I.	Tr. E.	8 6		II.	Tr. I.	10 37
	I.	Tr. E.	11 56	15	II.	Sh. I.	7 45	24	II.	Oc. R.	8 25
6	I.	Oc. R.	9 5		II.	Tr. I.	8 24	27	I.	Oc. D.	11 57
	II.	Ec. D.	10 54		II.	Sh. E.	10 37	28	I.	Sh. I.	9 15
8	II.	Sh. E.	8 4		II.	Tr. E.	11 13		I.	Tr. I.	9 16
	II.	Tr. E.	8 59	19	III.	Sh. I.	8 53		I.	Sh. E.	11 34
12	III.	Sh. E.	8 23		III.	Tr. I.	9 49		I.	Tr. E.	11 34
	III.	Tr. E.	9 51	20	I.	Ec. D.	10 4				
	I.	Sh. I.	10 59	21	I.	Sh. I.	7 21				

"Oc. D." denotes the disappearance of the Satellite behind the disc, and "Oc. R." its reappearance; "Tr. I." the ingress of a transit across the disc, and "Tr. E." its egress; "Sh. I." the ingress of a transit of the shadow across the disc, and "Sh. E." its egress; "Ec. D." denotes disappearance of Satellite by Eclipse, and "Ec. R." its reappearance.

Saturn (Feb. 1, R.A. $0^h\ 26^m$; Dec. N. 0° 19′. Feb. 28, R.A. $0^h\ 37^m$; Dec. N. 1° 28′) is observable for a few hours after sunset, as he sets at 9.47 p.m. on the 1st and at 8.17 p.m. on the 28th. The planet is a conspicuous object in the South-West portion of the sky, and appears in Pisces a few degrees South-East of the square of Pegasus. Observed in the telescope, the ring appears slightly open since we are looking on the Southern surface at an angle of about 7°. The apparent diameters of the outer major and minor axes of the ring are 38″·2 and 4″·5 respectively, whilst the diameter of the ball is 15″. In the telescope, in addition to the ring, the belts on the planet's disc—although not so conspicuous as those on Jupiter—may easily be discerned. The Moon appears near the planet on the 22nd.

Uranus (Feb. 14, R.A. $19^h\ 23^m$; Dec. S. 22° 30′) is a morning star, rising about 6.40 a.m. at the beginning of the month.

Neptune (Feb. 14, R.A. $7^h\ 4^m$; Dec. N. 21° 53′) is situated in Gemini, nearly midway between the stars ζ and δ Geminorum. The planet is on the meridian about 9.30 p.m. near the middle of the month, and is practically above the horizon the whole night throughout the month. He is difficult to detect except in large telescopes, but he may be identified in small telescopes by his relative motion if successive observations are made some few days apart.

METEOR SHOWERS:—

Date.	Radiant. R.A.	Radiant. Dec.	Near to	Characteristics.
	h. m.			
Feb. 5·10..	5 0	+41°	η Aurigæ	Slow; bright.
,, 15..	15 44	+11°	α Serpentis	Swift; streaks.
,, 20..	12 4	+34°	Cor Caroli	Swift; bright.

Minima of Algol occur on the 12th at 10.57 p.m., and on the 15th at 7.46 p.m.

DOUBLE STARS.—*Castor*, separation 5″·6, mags. 2·7, 3·7. Excellent object for small telescopes. The brightest pair to be observed in this country; can always be relied upon as a good show object.

κ Geminorum, separation 6″·3, mags. 4, 8·5; very pretty double.

ζ Cancri, separation 1″·1, 5″·1, mags. 5·5, 6·5, 7·5; with small telescopes the wider component is readily seen.

ν Draconis, separation 61″·7, mags. 4·6, 4·6; a pretty and easy double, can be separated by observing with a pair of opera glasses.